POWER-LOOM WEAVING

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POWER-LOOM WEAVING

POWER-LOOM WEAVING

AND

YARN NUMBERING, ACCORDING TO VARIOUS SYSTEMS, WITH CONVERSION TABLES

AN AUXILIARY AND TEXT-BOOK FOR PUPILS OF WEAVING SCHOOLS, AS WELL AS FOR SELF-INSTRUCTION, AND FOR GENERAL USE BY THOSE ENGAGED IN THE WEAVING INDUSTRY

POPULARLY TREATED BY

ANTON GRUNER

OF THE IMPERIAL ROYAL WEAVING SCHOOL AT ASCH

WITH COLOURED DIAGRAMS

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PREFACE.

Although the literature of the important industry of weaving has been enriched of late years by a great number of valuable and standard works, dealing with the various types of looms and their appliances, the learner often has to seek in vain for enlightenment on different obscure points therein.

The considerable difficulties often encountered by those engaged in power-loom weaving—evidence of which is afforded by the numerous questions addressed to the Trade Journals—speak for the necessity of dealing with the matter of obviating or eventually overcoming the inconveniences in question, since, notwithstanding that several works treating on the practical side of the subject are in existence, not every one is in a position to possess copies of large books.

Consequently, animated by a desire to comply with the widely expressed wishes of intending students of practical weaving, the author has endeavoured in the present small work to fill a

gap in the extensive domain of textile mechanism, and to afford explanations tending to that object.

In the first place a short review is given of the power-loom as a whole, followed by a description of the mounting of the different parts of the machinery, with their advantages and defects.

Illustrations have been omitted, the reader being presumed to already possess a suitable acquaintance with the subject.

The inclusion of the various systems of numbering yarn, together with certain calculations useful in weaving, was decided upon, since the object of the work is not to specialise but to form a handbook of general utility.

The author trusts that this outcome of his lengthy experience will meet with a friendly reception and be found to fulfil its purpose of constituting a book of reference for those engaged in weaving, and afford instruction to learners.

ANTON GRUNER.

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INTRODUCTION.

POWER-LOOM Weaving had its origin in England, and the idea of imparting motion to the entire loom from one of its parts dates as far back as the sixteenth century.

Edmund Cartwright, who took out letters patent in 1785, must be considered the actual inventor of the power-loom. His invention was soon followed by others, and multifarious improvements, based on the practical experience gained in the progress of the art, were introduced, in consequence of which power-loom weaving assumed continually-increasing dimensions, and hand-loom weaving concurrently lost ground.

At present there are a number of noteworthy manufacturers of weaving machinery, the most important of whom will be referred to in the following pages.

SECTION I.

POWER-LOOM WEAVING IN GENERAL.

By the term "power-loom" is understood a machine in which the motions necessary for the production of a textile fabric, and hitherto imparted by hand, are effected automatically.

The movements in question are transmitted throughout the entire mechanism by means of a portion thereof, known as the driving gear.

Of this gear there are several kinds, distinguished as:—

1. Pulley driving gear, or the English system.
2. Friction gear, or the German system.
3. Lockwheel and pawl gear, or Schönherr system.

The first of these methods, the pulley driving gear, consists of two pulleys, one "fast," *i.e.*, keyed or screwed on to the driving shaft of the loom, to which it transmits motion, and the other, the "loose pulley," loosely mounted on the shaft, for the purpose of bringing the loom to a standstill.

Friction driving gear consists of a conical boss firmly keyed or otherwise fixed to the shaft, and of a driving pulley, the nave of which is hollowed to fit the said cone, the pulley itself being mounted loose on the shaft. The cone may be either turned smooth or covered over with leather.

Fast-and-loose-pulley gear is mainly used in light, quick-running looms, whilst friction gear is employed more for heavy machines (cloth, buckskin, carpet, etc., looms).

In the case of fast-and-loose-pulley driving, the loom does not stop instantaneously when thrown out of gear, a short time being consumed in transferring the driving belt from the fast pulley to the loose one. On the other hand, with friction gear the machine stops immediately.

The Various Systems of Looms.

Looms are usually named either after the system of construction, the maker, or the class of goods for which they are destined. Thus we have the Atherton, Crompton, Dickinson (Blackburn), Hodgson (Bradford), Hattersley, Haggenmacher and Wassermann, Knowles, Schönherr, Smits Brothers, and other systems.

Loom Manufacturers.

In England : George Hodgson, Bradford ; G. Hattersley & Son, Keighley ; H. Livesey, Blackburn ; George Keighley, Burnley ; Atherton Brothers, Preston ; Platt Brothers, Oldham ; Hutchinson and Hollingworth, Dobcross ; John Crossley, Halifax ; Hacking & Co. ; Robert Hall & Son, Bury, near Manchester ; Felber, Jucker & Co., Manchester ; and others.

In Germany : Sächsische Webstuhlfabrik, late Louis Schönherr ; Sächsische Maschinenfabrik, late Richard Hartmann, Chemnitz ; Grossenhainer Webstuhlfabrik, late Anton Zschille, Grossenhain ; Hermann Schroers, Crefeld ; and others.

In Austria : Gülcher & Schwabe, Biala ; Otto Müller, Harzdorf, near Reichenberg ; A. Hohlbaum & Co., Jägerndorf ; C. A. Roscher, Georgswalde ; Gustav Thiele, Rumburg ; and others.

In Switzerland : C. Honegger, Ruti ; Jäggli, Oberwinterthur ; Gebrüder Benniger, Uzwyl ; and others.

In America: G. Crompton, Worcester (Mass.); J. Lyall, New York; and others.

In general, distinction is drawn between the following kinds of looms:—

(*a*) According to the lifting arrangements: inside or outside treadles, dobbies and Jacquards.

(*b*) According to the mode of changing the shuttles: single shuttle looms, circular box looms, eccentric circular box looms, drop box looms (on one or both sides of the loom).

(*c*) According to the picking motion: under-pick, central-pick (also known as over-pick), and true over-pick (Haggenmacher and Wassermann system).

Goods Produced on Power-Looms.

Fustian, cotton trouserings, ribbons, bed-ticking, bed-covers, cotton plush, cotton velvet, billiard cloth, canvas, cassinets, cottons, congress, chiffon, mantle stuffs, damask, double velvet, double plush, drills, coverlets, wire cloth, satineens, flannel, felt cloth, linings, polishing cloths, curtains, rubber cloth, jute goods, men's worsted stuffs, head cloths, clothing stuffs, linen trouserings, runners, mattress ticking, mohair plush, upholstery stuffs, muslin, moquettes, Oxfords, portières, piqué and pile carpets, especially:—

1. Uncut looped carpets (Brussels), with warps of different colours.

2. Pile Tournay velvet or Wilton carpets, with many-coloured warps.

3. Uncut looped carpets (tapestry), printed in the warp or in the piece.

4. Pile tapestry velvet, printed in the warp or in the piece.

(Axminster or chenille carpets are mostly made in hand-looms.)

Other carpets :—

1. Kidderminster (2-thread plain weavings).
2. Scotch (3-thread plain weavings).
3. Runners.
4. Twill carpet.

Beltings, silk goods, serviettes, sailcloth, tapestry, canvas, hose, heavy trouserings (Manchester), cloth and buckskin, tablecloths, handkerchiefs, cloth covers, wrapperings, under-linen, vest materials, zephyrs, twills, etc.

The Ordinary Loom in Comparison with Dobbies and Jacquards.

In ordinary looms only such weavings can be carried out as do not require any large number of picks to a repeat. Thus, for instance, small or "English" looms are constructed for 2 to 10 picks. By means of a star wheel and stud the number of picks can be increased to 14 for each revolution of the eccentric, the latter remaining at rest during the passage of the shuttle and only making a rapid movement during the changing of the shed. This class of eccentric is employed for heavy (cloth and buckskin) looms.

On the other hand, for weaving requiring a large number of picks to a repeat, a dobby or shaft loom must be used, this class of loom enabling the use of as many picks to a repeat as the card space on the machine allows.

Dobbies for small or "English" looms are generally built for 16 to 24 shafts; or, in the case of heavy (buckskin) looms, for as many as 43 shafts. If the repeat necessitates a larger number of shafts, then the Jacquard comes into use.

Dobbies are classified as single-lift (top-shed), double-lift (top-and-bottom-shed), and open-and-closed-shed machines.

Jacquards are divided into single-lift (top-shed), double-lift (top-shed), and top-and-bottom-shed (the latter being also constructed for sloping-shed).

Makers of Dobbies and Jacquards.

Sächsische Webstuhlfabrik, late Louis Schönherr, Chemnitz (the Schönherr Dobby).

G. Crompton, Worcester (the Crompton Dobby).

Gülcher & Schwabe, Biala (Dobbies).

Hutchinson & Hollingworth, Dobcross (Dobbies).

Geo. Hattersley, Keighley (the Hattersley Dobby).

Geo. Hodgson, Bradford; Hahlo & Liebreich, Bradford (Dobbies).

V. Lacasse & Co., Chemnitz (Lacasse Dobbies, for top-, bottom-, and sloping-shed).

L. Knowles, Worcester (Dobbies).

Frerich's Patent Dobby, Bradford.

John Bland, Keighley (Dobbies).

H. Livesey, Blackburn (Tannwalder Dobbies).

G. A. Roscher, Georgswalde (Wenzel's "Triumph" Dobby).

Sächsische Maschinenfabrik, late Richard Hartmann, Chemnitz.

Otto Müller, Harzdorf-Reichenberg.

Beck & Co., Atzgersdorf, near Vienna.

H. Güntsche, Gera.

Grossenhainer Webstuhlfabrik, Grossenhain.

Devoge & Co., Manchester.

Heinrich Blank, Uster.

Schelling & Stäubli, Horgen-Zurich.

Gustav Thiele, Rumburg.

J. Horak, Lomnitz.

C. M. Auerbach, Chemnitz.

And others.

Drop-box Motions.

Of these may be mentioned the systems of Hacking, Honegger, Smits, Hofmann, Schönherr (Sächsische Webstuhlfabrik), Schwabe (Gülcher), Otto Müller, Grossenhain (formerly Ant. Zschille), Knowles, etc., etc.

SECTION II.

MOUNTING AND STARTING THE POWER-LOOM.

English Looms.

Tappet or Treadle Looms.

By the term "tappet" or "treadle" loom is understood one in which the raising of the shafts (shed formation) is effected by tappets. These looms are divided into two classes: inside- (or central) and outside-treadle looms.

A. *The Inside-treadle Loom.*

In this class of loom the tappet for plain weaving is generally mounted on the picking-tappet shaft. In exceptional cases wheel gearing is introduced, whereby 3- or 4-thread weaving can be effected. In the former case the treadle levers are movably mounted below on the rear cross frame, but in the latter case on the front frame.

For plain weavings this arrangement is preferred on account of its simplicity, but is less to be recommended for 3- or 4-thread fabrics; since here, in place of a head shaft, rollers must be employed, and, besides, the parts below the warps are rather inaccessible.

B. *The Outside-treadle Loom.*

This kind of loom is usually constructed for up to 6 shafts, although the number may be increased to 8 or 10. Motion is imparted from the main shaft through wheels on the picker shaft, on which—outside the frame—a cannon wheel,

made in one piece with the cog wheel, is pushed on the tappet, and fixed thereon by clamping screws.

In setting a loom of this kind the shafts can be adjusted with the greatest ease by means of the draft cords or shaft straps.

The reversing (or under-) motion is here effected by springs attached to the flooring.

Setting the Compound Tappet.

A simple cast tappet enables only one definite class of weaving to be carried on; but the case is altered when the tappet is composed of several discs, the character of the weaving being changed by adjusting the relative position of the discs.

The tappets, each of which actuates a shaft, are divided into as many sections as there are picks to a repeat in the weaving. Each section is bored for the insertion of a screw, so that a tappet divided into six sections, for instance, contains six screw holes, serving to unite the several discs to form a whole, three or four screws being required as a rule. The repeat corresponds to the number of sections employed to make up the tappet; hence a weaving with six warps and six weft threads requires six tappets, each composed of six sections.

The projecting (eccentric) portions generally correspond to the marked squares, whilst the depressions correspond to the blanks on the pattern sheet.

Before proceeding to set the tappet, it must first be ascertained whether the projections and depressions of each tappet are in accord with the weaving to be carried out. When this is settled, the procedure is as follows:—

The pattern design is taken and counted from below upwards, to the left of the first warp thread, the tappet disc being placed upright, and the upper side turned for-

wards for the purpose of comparison, so that the marked squares agree with the projections and the blanks with the depressions. The position corresponding with the lowest square is marked with chalk, and the whole of the discs required for a warp repeat are treated in the same way. The chalk marks, which should, for preference, be made near the screw holes, indicate in each disc the first square or first pick, and must all coincide when the discs are screwed together.

It is also advisable to number the discs, that of the first warp thread being marked 1, the next 2, and so on. The combined tappet is then pushed on to the boss of the tappet shaft in such a manner that when viewed from the front the first disc is at the right hand side of the set, and the last one at the extreme left, whether the loom be driven from the right or the left hand side. The hindmost or first of the draft rods leading from the bowl levers to the cross-frame bars must meet the first tappet disc, and the foremost or last rod the last disc.

When this has been carried out in the above manner, the movement of the threads in shedding will be in accordance with the pattern.

Of the draft rods attached to the cross-frame rods, the lower or foremost will, as a rule, be the widest, the upper or hindmost being drawn in narrower towards the centre.

It should be noted that in a single revolution of the tappets the loom must make as many picks as are contained in a repeat of the pattern that is being woven. It may also happen that two repeats are made by a single rotation, so that, for example, in the case of a 3-thread pattern, six picks are made during each turn of the tappet; and by means of change wheels the rotation of the tappet can be regulated to terminate after any convenient number of picks.

Drop-box Motion.

The number of motions is too large to permit of full discussion of the various details in the present work.

They are divided into single- and double-action (pick-and-pick) motions, and, as a rule, consist of four boxes. Buckskin looms are almost exclusively built with double-action, 2-box (triple) to 6-box (11-fold) motion.

Whereas in the case of single-action drop-box motions the shuttles can only be changed after an even number of picks, double-action box motions enable the weft to be changed after any convenient number, odd or even. Greater results are obtainable from independent double-action box motions —used principally in heavy looms—by means of which three shuttles can be used with two boxes, five with three, seven with four, nine with five boxes, and so on.

The raising or lowering of the box must commence at the same moment as both cranks of the crank shaft attain their highest position, and in the case of one-sided motions the next following stroke of the picker must take place from this side of the change box.

The bottom of the boxes must be exactly flush with the shuttle race, neither higher nor lower.

Whatever type of lifting motion be employed for the boxes, a safety attachment (coupling) must be provided. Should any hindrance to the lifting or lowering of the boxes arise, whether from the sticking of the picker or the jamming of the shuttle, which might easily lead to the breakage of some of the parts, the coupling becomes detached. Care is necessary to see that the coupling neither requires too much force to become detached, nor comes undone too easily, since in the former case (which seldom happens) a smash will result or the driving belt will be forced off, whilst in the other event the coupling will be frequently coming undone or else the boxes will not come exactly flush with the shuttle race.

The Picking Motion.

As already mentioned, this motion is divided into two classes, over- and under-picking.

The Over-pick.

This form is principally used in small "English" looms, especially revolving-box looms.

Inside the loom an eccentric (the picker tappet) is keyed on either side (right and left) of the under- or tappet shaft, the tappet noses being at an angle of 180° to each other. A striker shaft fitted with a striking roller is placed vertically on each side frame, outside the loom, in such a position that the striking roller makes contact with the tappet.

The tappet shaft makes one complete turn to every two turns of the loom, and consequently the noses of the tappets act alternately on the striking shafts. In the meantime the tappet shaft is turning through an angle of 45°, the motion being transmitted to a wooden striker firmly screwed on to the upper end of the striker shaft. By means of the picking strap the striker imparts a powerful shock to the picker, which is mounted on the picker spindle, and forces it towards the centre of the loom. The reverse motion is produced by the action of a spiral spring connecting the striker shaft with the frame of the loom.

To adjust the picker stroke, both cranks on the crank shaft are moved until they point vertically downwards. This opens the shed more than half way, the lathe is moved half way towards the rear, and—since a short time will elapse before the picker strap becomes tightened and the shuttle arrives at the shed—the nose of the tappet may now begin to engage with the striking roller; in fact, the latter should rest exactly in the hollow of the tappet.

Slots are provided in the tappet to enable the tappet nose to be adjusted and fixed by the aid of a couple of screws.

To quicken the stroke the screws are loosened and the nose drawn forward, whilst for retarding the stroke the nose is pushed further back, and then re-fastened by tightening the screws up again.

To fix the strikers the loom is set in motion until the point of the tappet nose points exactly to the centre of the roller, *i.e.*, the middle of the periphery. The roller must not project above the nose. It is best to key the tappet in such a position that the extreme point of the nose coincides with the edge of the roller. Should the stroke be insufficiently powerful, a remedy is afforded by fixing the roller in a lower situation in the slot in which it is mounted. If, however, this does not completely effect what is required, the tappet is keyed a little nearer the striker shaft, but this should be resorted to in extreme cases only, since it generally makes the stroke rather harsh and causes the loom to stamp.

Another principal condition is to lay the roller true against the tappet nose; unless this is done the roller is struck unevenly and will soon become unfit for use.

At the instant under consideration the striker will have attained its extreme position, and its end should now be situated exactly above the striking point of the picker—or frequently a little nearer the centre of the loom. The position may be accurately adjusted at convenience by means of a clamping screw at the upper extremity of the striker shaft.

Next follows the attachment of the picking band to the striker. When the latter is provided with a slot for the reception of the band it is preferable to insert the strap into the groove from the outside, since this course obviates severe breakages and increases the durability of the strap.

At the moment already referred to, the picker must be exactly in position for action, and the picking band must be correspondingly wound round the striker, and fixed by a nail to prevent it from coming undone. It is necessary to see

that the picking band is not stretched taut between the striker and the picker, but retains a certain elasticity, since, otherwise, the stroke is too harsh, or there is risk of smashing the striker.

Under-picks

are chiefly used for heavy and wide looms, although they also find employment in small looms. Their principal advantage consists in the picker spindle being in front of or behind the shuttle box instead of above it. Consequently all risk of the goods becoming soiled by grease from the picker spindle is totally precluded, a point of sufficient importance in delicate fabrics.

This kind of picking motion is of special value in silk looms. Recently, however, looms have been constructed without any picker spindles (Maschinenfabrik Ruti, late Caspar Honnegger).

The disposition of the striking mechanism differs considerably in the various under-pick systems. Thus, for example, there are some in which the two picking tappets are mounted on the picking tappet shaft like the English over-pick looms. In others, again, one tappet is mounted on the loom frame; or one or both tappets mounted on the crank shaft below; and so on. These last three arrangements are mostly met with in wide heavy looms.

As a general thing—except in revolving box looms—under-picks are used both on single-shuttle and multiple-shuttle looms.

The Shuttle Race.

The shuttle should not enter the shed until the latter is sufficiently opened and the lathe drawn far enough towards the rear. The speed must however be so high that the shuttle leaves the shed again before the same begins to

close. Should it enter too soon, or leave too late, the result will be the breakage of threads at the edges of the warps, or weaving faults will be produced by the shuttle missing some of the threads. For preventing the shuttle from leaving the box too soon, or rebounding after a stroke, checks (swells) exerting a constant pressure are provided in the shuttle boxes, these checks being acted upon by arms behind the lathe and in connection with the protector shaft, which arms are pressed against the checks by spiral springs attached to the foot of the lathe.

If the shuttle rebounds in the box after its passage through the shed, one or other of the springs may be drawn out a little. To enable the shuttle to make a good passage it must make close contact with the picker, but the pressure must not be very great or the warp will suffer.

In the case of drop boxes, care must be taken that the box is at rest and flush with the race before the shuttle is sent on its journey. Similarly, the changing of the boxes must not take place before the shuttle has properly arrived.

Revolving boxes are fitted—in place of swells—with slightly bent steel springs which check the shuttle. Here, also, in extreme cases, assistance is afforded by bending the springs to a greater or smaller extent.

Moreover, every loom is fitted with a check strap, which, by shortening or lengthening, stops the rebounding of the shuttle.

The Stop Rod or Warp Protector.

This appliance is of infinite importance in the working of the power loom, since, without it, weaving in such looms would be attended with the imminent danger of continual smashings of the warp threads.

The shuttle passes through the shed at each pick of the loom, and if from any cause, such as the breaking of a

thread, striker or picking band, it should become checked in its passage and stick in the shed, then the lathe would press it into the fabric, and the whole length of warps would be smashed.

This is obviated by the employment of the warp protector in the case of looms with fast reeds, no matter whether single shuttles or drop boxes are used. Revolving box looms are fitted merely with a reed checker.

The stop rod consists of a shaft underneath and parallel to the lathe, and fitted on either end with projecting stop arms, forming one piece with the shaft. In addition to this, arms situated at each end of the lathe are directly or indirectly connected with the same shaft, and kept in contact with the swells by means of spiral springs attached to the shaft and the foot of the lathe.

When the shuttle enters a box, the swell and contact arm are forced back, the arm and shaft making a circular movement which causes the stop arms to swing in an upward direction.

On the frame of the loom are mounted two buffers ("frogs"), over which the stop arms slide at each stroke of the lathe, provided the shuttle has reached its box. If, however, the shuttle has failed to do so, the stop arms impinge on the buffers and thus stop the lathe and prevent the loom from working.

To reduce the shock on the lathe, the buffers are fitted with india-rubber; or else iron cores are inserted through the frame and make contact with powerful springs.

In adjusting the protector, it should be arranged in such a manner that, whenever there is no shuttle in the box, the stop arm engages fully with the buffer. If this is not properly done, warp smashes are likely to occur on the one hand, or conversely, if the setting be too deep, the loom may often be unnecessarily thrown out of gear.

The swing of the stop arms should be limited to a small arc, since, when the shuttle is in the box, they need only be $\frac{1}{8}$ to $\frac{1}{5}$ of an inch above the buffers.

Throw-out Gear.

A starting lever (setting-on handle) is fixed to the loom frame on the driving side, and, when the loom is to be set in motion, is pushed over against a notch in the plate, against which it is mounted, and falls with its flat side into the notch by its own elasticity.

The starting lever actuates the belt fork, which during the starting motion describes an arc from the fast pulley to the loose pulley of the driving shaft, the former being fastened by screws to the shaft, and the latter mounted loose, but held in place by a collar.

A wiper which is mounted on the buffer next the driving side makes contact, when the loom is in gear, with an adjustable plate fixed to the starting lever. The contact between them should be close, but not so as to amount to actual pressure.

To stop the loom the lever is pulled out of the notch and flies forward by its own elasticity, thus causing the belt to be thrown off the fast pulley on to the loose one.

When there is no shuttle in the box the stop arm is not raised, and consequently, when the lathe advances, strikes on the buffer, which gives under the pressure, and causes the wiper to impinge on the starting lever and force it out of the notch.

The movement of the buffer being of small amplitude, the force exerted by the wiper would be insufficient to effect this dislodgment if the adjustable plate on the lever were not in contact with the wiper at the outset. On the other hand, if they press too hardly together, the starting lever will probably be prevented from engaging sufficiently in the notch,

and hence will shake out under the influence of vibration and bring the loom to a standstill. The plate is therefore fitted with a pair of adjusting screws to enable it to be set in the most favourable position.

Automatic Stopping by the Weft Fork.

It very frequently happens that the loom-minder omits to stop the loom directly the shuttle is empty; the more so because, in the case of simple weavings, one minder has to look after a couple of looms, a condition of things precluding stopping by hand.

It may also readily happen that the weft thread breaks and then, of course, in the absence of automatic stopping gear there ensues the risk, in multiple-shuttle looms, of the other shuttles continuing to act after one is empty, the result being a fault wherever that particular thread ought to have come in, thus producing a fabric thin in places—or, in the case of single-shuttle looms, an entire failure of weft threads.

To prevent this contingency a weft fork is affixed on the driving side, which fork, on the advance of the lathe, fits into a grid constructed in the latter. The fork is also put in connection with the starting lever, and while the loom is in gear is forced by the action of this lever in the direction of the lathe, so that when the crank axle reaches its front dead point, the fork projects about $\frac{1}{5}$ of an inch through the grid when no weft thread is overlying same.

At the end opposite to the prongs the fork is fitted with a small hook, which, at the instant under consideration, descends. On the other hand, if a weft thread interposes between the grid and the fork, the said prongs do not pass through, and the opposite end is raised.

A movable lever is mounted on the frame just below the

breast beam, and is provided at one end—where it has a vertical movement between the beam and the lathe—with a catch to engage with the hook aforementioned. The other end of this lever rests on a tappet, or on a bowl attached to a lever mounted on the tappet shaft, the said tappet being adjusted in such a manner that when the crank is at its foremost dead point, *i.e.*, the one next the fabric, the slightest forward movement of the loom causes the tappet to lift the lever arm.

As the tappet roller makes only one revolution for every two picks, it results that the movement of the lever arm follows every second pick; consequently in the above-named position of the crank shaft the shuttle must be in the box on the driving side, *i.e.*, the last pick must have been from the opposite side of the loom to the driving side.

If now, as already contemplated, a weft thread lies between the fork prongs and the grid the hook is lifted and the catch on the bent lever moves away underneath. If, however, the shuttle thread be exhausted or broken, then the prongs project through the grid, the hook descends, and, being engaged by the bent lever, is drawn forward, the lever connecting the fork with the starting lever comes into play and pushes the latter out of its notch, thus throwing the belt on to the loose pulley.

To prevent the ratchet wheel of the take-up motion from pulling the fabric one notch forward after the empty pick, and leaving a faulty place in the cloth, a projecting tongue, connected with the pawl by a bar underneath the breast beam, is provided in the starting gear plate and is drawn forward when the fork lever is depressed, thus disconnecting the pawl from the ratchet wheel.

In setting this part of the mechanism it must be seen to that, when in gear, the pawl engages completely with the ratchet and that the tongue is in a position to lift the

pawl on the slightest impulse on the part of the automatic stopping gear.

With regard to the setting of the weft fork, the following points should be borne in mind :—

1. The lift of the hook should not exceed $\frac{1}{5}$ to $\frac{2}{5}$ of an inch.

2. The fork prongs should be set as deep as possible so as to prevent the weft thread from passing below them; and the points must on no account abut on to the lathe.

3. The proper space to allow between the hook and the lever catch is about $\frac{1}{5}$ of an inch. When in good working order, the starting lever is forced out of its notch by the further forward movement of the loom.

Screws are fitted to all the parts mentioned and can be made use of when required.

The Brake.

Owing to the speed at which the loom works it would be impossible to bring it instantly to a standstill when thrown out of gear, and it would make one or two picks before stopping were it not for the brake provided for this purpose in every loom, and acting on a brake wheel keyed on the crank shaft outside the frame. To facilitate braking and at the same time protect the wearing parts, the brake is shod with leather.

The brake lever is also mounted on the outside of the frame, and one end reaches close under the starting lever plate, where it is provided with a pin engaging in a special brake handle working in the said plate.

On the pin, and underneath the lever, is situated an adjusting collar, set in such a manner that, when the brake is not acting, the collar is about $\frac{1}{8}$ of an inch from the lever, so that the leather-shod cheek of the brake can press freely on the wheel. To increase the braking power, the lever is

grooved for the suspension of a weight, which, when moved backwards or forwards, diminishes or increases the force of the brake.

When the loom is started the pin is raised, the setting collar lifts up the brake lever, and the brake is thrown off. Sometimes a spring is inserted on the pin, between the brake lever and setting collar, to keep the stopping lever from falling back. In such event the collar must be set low enough to enable the cheek to press on the brake wheel. It is necessary to see that the contact between these two parts last named is perfect, and that they are kept free from grease.

Setting the Shed.

This operation may be said to represent the soul of the process of weaving, for not only does bad setting lead to frequent smashes and thus inflict considerable loss on the weaver, but the saleable value of the goods is also greatly lowered thereby. For some fabrics this consideration is of little or no importance ; nevertheless there are others, in the manufacture of which the greatest care is necessary in this respect to avoid the risk of having a defective, unsightly and therefore less valuable product.

A bad shedding motion may result in thin, empty-feeling cloth, coiled warp or weft threads, numerous smashes, productive of unsightly goods, etc.

Each class of fabrics requires a special adjustment of the shedding motion.

As an exhaustive treatment of the subject would take up more space than is available in the present work, only the more important points will be mentioned, in order to enable the reader to cope with any difficulties that may arise.

In the first place, the shed must be opened sufficiently wide to admit the unrestricted passage of the shuttle. If

obstructed, the first result will be to cause a smash, and, in addition, the shuttle will be prevented from leaving the shed and entering its box in due time.

The lower shed must not lay too tightly against the shuttle race, and it is also disadvantageous for the same to be very far away from the race. A medium position should be maintained, since, in the former event, the lathe will push warp threads away, and in the other, the point of the shuttle is very likely to be diverted upwards on entering the shed, thus throwing the shuttle out of the loom.

The shafts ought to be arranged so that those in the lower position slope downwards and the higher ones upwards, to enable the latter, in consequence of their greater distance from the fell of the cloth, to stand further apart than those in front, thereby securing a fine clear shed.

To ascertain the time at which the shafts should alternate the following points must be observed :—

If the lathe is set so that the distance between the reed and the fell of the cloth amounts to $\frac{2}{5}$ of an inch, the tappet should be in such a position that the rising and falling shafts have accomplished one-half of their respective motions, and consequently the bowl levers should all be at the same level, none either higher or lower than the others.

The adjustment being effected in this manner, the certainty of a clear shed is established, and the warp is sure not to suffer any damage on that score. In exceptional instances the lathe, instead of being set at the above distance from the fell, is placed so as to make contact therewith, *i.e.*, the cranks on the crank shaft are both at the foremost dead point.

The draft beam must be set at exactly the same height as the breast beam, in order that the warp may run horizontally towards the latter. Though a higher or lower setting of the draft beam is adopted in many instances, the lower shed

should, as a rule, be a little looser than the upper shed, because if the lower shed be the tighter, the shuttle will be more likely to fly out at the top. Nevertheless, the draft beam is frequently set higher with advantage, in order to produce a superior article, and experience shows that in this manner the weft can be beaten up with greater ease.

In setting the dobby machine the shed should be closed; this is the case when the dobby crank on the picking tappet shaft points upwards, in a direction parallel to the swing rod of the machine.

Shaft Springs.

For the purpose of depressing the shafts in outside-treadle looms and negative dobbies, spiral springs attached to the floor (if possible) by ringbolts are employed.

Where the flooring is of concrete a wooden platform is placed under the loom for the purpose of receiving these bolts; or in some looms a cast-iron bar or some other appliance is provided for the attachment of the springs.

The length of the springs is about 14 to 16 inches, and the average thickness of the wire employed is $\frac{1}{16}$ to $\frac{1}{12}$ of an inch. The tension should not be so great as to cause injury to the shafts and warps from the strain.

Cords are suspended from the lower shaft rods and attached by means of loops to the springs. It is preferable to have the springs as low down as possible in order to prevent the knots and springs from coming in contact with the shafts when the latter are in motion.

In dobbies the springs are attached while all the shafts are in their lowest position.

In tappet looms the attachment is made to each set in turn as it reaches that position, the tension of the springs being adjusted so that each one is stretched about $\frac{2}{5}$ to 1 inch. When this tension is exceeded, the spring is over-

strained by the lifting of the shaft, and will no longer depress the latter to its normal position.

The Regulator, or Taking-up Motion.

Two classes of regulators are employed for winding the fabric on the cloth beam, *viz.*, positive and negative, the former being chiefly used for small quick-running looms, and the latter solely for such as are wider and heavier.

The following point enables the one class of regulator to be distinguished from the other: The positive regulator continues to advance as soon as the lathe begins to move forward, whether a weft has been inserted or not, whilst the negative motion only acts when a weft has been laid.

The Positive Regulator.

Underneath the breast beam is mounted a roller of wood or iron. If of the first-named material, it is coated with emery, sand or sheet metal, and if of iron, it may also be shod with metal or grooved, from which circumstances the roller is variously known as the emery, sand or grooved roller.

The regulator is mounted on the frame on the opposite side from the driving gear, and is arranged as follows:—

A single lever fitted with a pawl is mounted on the frame, so as to be capable of vertical motion. It is connected with an adjustable pin, which can be raised or lowered, and is screwed on to the foot of the lathe. The pawl engages in the teeth of a ratchet wheel, which it pushes forward one notch every time the lathe is moved.

Owing to the considerable tension exerted by the fabric, it would be impossible to retain the roller and ratchet wheel in position while the pawl retreats for the purpose of engaging in a fresh notch, were it not that a detent is provided,

which drops into a tooth on the ratchet wheel, and prevents it from slipping back.

A change wheel is mounted on the opposite end of the ratchet wheel spindle, and engages in the large cog on the intermediate wheel, the smaller cog of which engages with the beam wheel. As the latter is fastened by set screws on the beam, it is evident that this roller is rotated by the motion of the lathe.

Below and in contact with the grooved roller is placed the cloth beam, the pressure between them being occasioned by a couple of movable weighted arms or levers mounted on the sides of the loom. In place of levers other arrangements have latterly been devised for obtaining this pressure in a convenient and simple manner: *e.g.*, by mounting the cloth beam gudgeons in vertical racks, each of which engages with a small pinion attached to a pulley. A leather belt is passed over each pulley and led over a small roller on the frame of the loom, the overhanging end being attached to a weight. As the cloth beam becomes filled, it depresses the racks, whereby the pinions with their attached pulleys are caused to turn slowly, and the weights yielding, the belts are taken up on their respective pulleys.

In another method, a belt is laid on each of the gudgeons of the grooved roller, one end of each belt being fitted with a metal ring, which slips over the gudgeon of the cloth beam, whilst the other end terminates in a spring, which yields under the increased tension of the growing cloth beam.

To enable the tension to be increased or diminished, the springs are attached to leather straps, the further ends of which are wound round corresponding ratchet wheels, mounted on the traverse of the loom, and provided with detents to retain them in position.

This kind of positive regulators is in general use on narrow looms. There are other positive regulators, more in use on

wider looms, in which the change wheels are dispensed with, their functions being discharged by the detents on the ratchet wheels.

Calculating the Change Wheels and the Regulators.

The forward movement of the regulator is effected at each pick, and enables a larger or smaller number of weft threads to be inserted at will, per unit length of fabric, by the aid of change wheels of different counts of teeth, the usual range of teeth commencing at 15 and rising by singles to about 100. The greater the number of teeth in the change wheel the more open the fabric, *i.e.*, the smaller the number of picks per unit of length, and *vice versâ*.

In all the subjoined formulæ for calculating the movement of the regulator and the change wheels, it should be borne in mind that the ratchet wheel is moved forward one notch at a time. The ratchet wheel can however be moved forward quicker, *i.e.*, two or three notches at once, by lengthening the pin on the foot of the lathe, whereby the movement of the pawl is amplified. To ascertain the rate of advance, the lathe is drawn out as far as it will go, and then slowly pushed back until it touches the fabric, a note being taken of the number of notches pushed forward by the pawl during this operation. If the advance is at the rate of two notches, the number of picks will be only one half, or if three notches, one third, the number inserted per unit length of cloth by a one-notch motion.

The ratchet wheels are also made in different sizes, *viz.*, with from about 50 to 100 teeth. The larger the wheel the closer the weaving, whilst on the other hand, the cloth is taken up quicker in proportion as smaller wheels are used, and, consequently, a fabric of more open texture is produced.

The universal rule in calculating the change wheels is to divide the driving wheel by the driven one.

Usually three trains of wheels go to form a taking-up motion :—

Train 1. The ratchet and change wheels.

,, 2. Stud pinion and stud wheel.

,, 3. Beam wheel and circumference of roller.

The first named is therefore always the dividend and the last named the divisor; and in order to ascertain the size of change wheel required to produce a given number of picks per 1 centimetre, the following procedure is adopted :—[1]

In the first place, it is necessary to discover by how many teeth the stud wheel must be advanced to move the beam wheel through 1 centimetre. To do this, the circumference of the grooved roller in centimetres is divided into the number of teeth on the beam wheel (set 3), the answer being the number of teeth on the latter moved forward when the beam advances 1 centimetre. Then the number of teeth on the stud pinion is divided into the number of teeth on the stud wheel (set 2), the result giving the number of teeth on the latter that must be moved forward to advance the stud pinion by one tooth. On multiplying the quotients together, the answer expresses the number of teeth to be moved on the stud wheel to advance the beam through 1 centimetre. For example :—

Train 3.—Grooved roller, 36 centimetres (14 in.). Beam wheel, 125 teeth.

Train 2.—Stud pinion, 19 teeth. Stud wheel, 125 teeth.

Then : $125 \div 36 = 3{\cdot}47$ teeth.

$125 \div 19 = 6{\cdot}58$,,

$3{\cdot}47 \times 6{\cdot}58 = 22{\cdot}8326$, or in round numbers, 23 teeth.

Thus it is evident that the beam wheel must advance by

[1] *Translator's Note.*—1 centimetre = 0·3937 inch, and 2·55 centimetres = 1 inch; therefore the results, *i.e.*, teeth and picks, per centimetre multiplied by 2·5 will give the corresponding figures per inch.

3·47 teeth to bring the beam wheel 1 centimetre forward; and as the ratio between stud wheel and stud pinion is 6·58 : 1, the multiplication of these two values gives 23 as the number of teeth to be moved on the stud wheel to advance the beam by 1 centimetre (or 59 teeth for an advance of 1 inch).

Thus number 23 is a constant, and we will therefore call it the regulator number. Of course this constancy applies only to one system of looms, since in others the dimensions of the beam and the count of the wheels differ from those above given. It is therefore desirable when dealing with new looms to ascertain this constant in each case, in order to have a correct basis to start with.

There is also another and simpler way of determining this constant, namely, by multiplying the number of teeth on the stud wheel by those of the beam wheel and dividing the product by that obtained from the multiplication of the measure of the roller on the number of teeth in the stud pinion, *e.g.* :—

Beam wheel, .	125 × 125 stud wheel =	15,625
Roller circumference,	36 × 19 stud pinion =	684

$$15{,}625 \div 684 = 23 \text{ teeth.}$$

From the regulator constant it is easy to determine the principal constant by multiplying the former on the count of the ratchet wheel, *e.g.* :—

$$23 \times 60 \text{ (ratchet wheel)} = 1380.$$

On dividing this by the desired number of picks, we obtain the number of teeth required for the change wheel, *e.g.*, for 38 picks per 1 centimetre (97 per inch) :—

$$1380 \div 38 = 36\text{-tooth change wheel.}$$

The principal constant is the one on which all change-wheel calculations are based in practice. If a different ratchet wheel is substituted, then all that is necessary is to multiply the regulator constant by the count of the new

wheel and the new principal constant will be obtained. The substitution of a fresh count of wheel in the second or third train will alter the regulator constant and consequently the principal constant as well.

To determine the number of picks per centimetre that a given change wheel in the loom will produce, the calculation must be reversed, starting with the first train, *e.g.* :—

Train 1.—Ratchet wheel, 60 teeth. Change wheel, 45 teeth.

Train 2.—Stud wheel, 125 teeth. Stud pinion, 19 teeth.

Train 3.—Beam wheel, 125 teeth. Roller circumference, 36 centimetres.

Then: (1) $60 \div 45 = 1{\cdot}33 : 1$; ratio between ratchet- and change wheel.

(2) $125 \div 19 = 6{\cdot}58 : 1$; ratio of spur wheel to spur pinion.

(3) $125 \div 36 = 3{\cdot}47$ teeth on the beam wheel to be moved, to advance the roller 1 centimetre.

(4) $1{\cdot}33 \times 6{\cdot}58 \times 3{\cdot}47 = 30{\cdot}367358$, *i.e.*, a 45-tooth change wheel gives 30 picks per centimetre of fabric (77 per inch).

Here again the operation may be simplified by multiplying together the counts of teeth on all the driving wheels and dividing the product by the product of the driven wheels, *e.g.* :—

60 (ratchet wheel) × 125 (spur wheel) × 125 (beam wheel) = 937,500.

45 (change wheel) × 19 (spur wheel) × 36 (roller circumference in centimetres) = 30,780.

$$937{,}500 \div 30{,}780 = 30 \text{ picks.}$$

When the regulator constant is already known, the calculation is very much shorter. For example:—

60 (ratchet wheel) × 45 (change wheel) × 23 (regulator constant) = 30·59, or 31 picks.

The system of measures employed, whether English, metric, or what not, is immaterial to the accuracy of this

calculation, since according to the unit of measurement adopted for measuring the circumference of the roller, the answer in picks per change wheel will be referable to that unit.

Still another method may be given, in which the problem is to find the change wheel for a finer weft than is being inserted, *e.g.*, supposing No. 46 weft to have been used with a 32-tooth change wheel, what sized wheel will be needed for use with a No. 54 weft?

The solution is effected by multiplying the two first-named figures together and dividing the product by the number of picks to be produced, *e.g.* :—

$$\frac{46 \times 52}{54} = \frac{1472}{54} = 27.$$

Thus a 27-tooth wheel will be required. In reversing the problem and endeavouring to find the change wheel to use with a stouter weft than is being woven, we must proceed as follows :—

Say, for instance, that a 27-tooth wheel has been used for No. 54 weft and the problem is to find the corresponding wheel for No. 46 weft, the two first-named figures are multiplied together and the result divided by the future weft.

$$\frac{54 \times 27}{46} = \frac{1458}{46} = 31\tfrac{32}{46}.$$

Thus a 32-tooth wheel will be required.

In all calculations of this sort the remainder left on division is neglected if it falls below $\frac{1}{2}$, above which limit it is counted as a whole number.

It not infrequently happens that, in spite of accurate calculation, differences arise in the count of weft. These are attributable to the disposition of the taking-up roller. Consequently it is desirable to employ rollers covered with perforated strips of sheet metal wound spirally, such an

arrangement resulting in a more reliable taking up of the fabric.

If it should be found that a roller, after having been a long time in use, has ceased to take up accurately, and that the fabric consequently contains more picks per unit of length than it should do, then in such event the substitution of a larger change wheel than was calculated will be necessary. To determine the size of wheel required will not be difficult if the number of picks actually found per unit of cloth be divided by the excess. The answer gives the fraction by which the total existing picks must be reduced, and consequently the fraction by which the total number of teeth on the change wheel must be increased, in order to produce the desired effect.

To take as an example the case where 65 picks per centimetre are desired, but where it is found that the fabric actually contains 72 picks, with a change wheel of 21 teeth: to find what size wheel must be used to correct this error—

Actual picks	72
Required picks . . .	65
Excess	7

Then $72 \div 7 = 10$, so that the reduction to be effected is one-tenth of the total, and as this fraction of the change wheel $21 \div 10 = 2$ teeth the new wheel will need to have $21 + 2 = 23$ teeth in order to produce 65 picks per centimetre.

The variation can also be calculated by another method, *i.e.*, by multiplying the actual count (picks) by the change wheel, and dividing the product (the new principal constant, including the variation) by the desired weft count, *e.g.*:—

Actual count 72×21 (No. of teeth in wheel) $= 1512$, which $\div\ 65$ (desired weft count) $= 23$ (No. of teeth in substituted wheel).

The foregoing examples will facilitate the correction of any variations ensuing from defective action of the grooved taking-up roller.

Another Method of Calculating the Change Wheels and Taking-up Motion.

In the taking-up motion hitherto described the rule obtains that the smaller the change wheel the closer the weft, and *vice versâ.*

The case is, however, different in taking-up motions (*e.g.*, of the Hattersley loom) wherein the change wheel takes the place of the stud wheel, and the pinion replacing the change wheel on the ratchet wheel shaft (and now known as the driving wheel) is keyed fast and therefore is not interchangeable.

When this is the case the ordinary conditions are reversed and the closeness of the weft varies directly with the size of the change wheel.

To determine under such conditions what size change wheel is required to produce a given number of picks per unit length of cloth (*e.g.*, per centimetre) or how many picks a given wheel will allow, the regulator constant must first be ascertained by multiplying the driving wheel by the stud pinion and the product by the circumference of the taking-up roller, the result being divided by the product of the ratchet wheel and beam wheel. Take for example :—

Driving wheel .	32 teeth	Ratchet wheel .	67 teeth
Stud pinion . .	17 ,,	Beam wheel. .	127 ,,
Roller circumference 36 centimetres			

Then : $32 \times 17 \times 36 = 19{,}584$

$67 \times 127 = 8509$

$19{,}584 \div 8509 = 2{\cdot}3$ = regulator constant.

The constant remains unaltered except in cases where one or another toothed wheel, or the ratchet wheel, is changed, whereupon the constant naturally undergoes modification.

In order to ascertain what size change wheel is necessary to produce a given count of picks, the latter number is first multiplied by the constant, *e.g.*, in the case of 26 picks per centimetre: $26 \times 2{\cdot}3 = 59{\cdot}8$, or in round numbers, 60. That is to say, a 60-tooth change wheel will be required.

To make the converse determination and find the number of picks that a given wheel will produce, the wheel count is divided by the regulator constant. Thus, reversing the above figures:—

$60 \div 2{\cdot}3 = 26$ picks per centimetre will be produced by a 60-tooth change wheel.

The Expansion Catch.

Although nearly every loom is fitted with a weft fork, which throws the loom out of gear whenever the weft thread fails to interpose between the fork and the corresponding slot, it is nevertheless likely to happen that the weft thread may break off short in the box, close beyond the fork, or the shuttle may run out. In either case the loom would still make two or three revolutions before stopping, since the fork only comes into action at every second pick; and as the taking-up motion continues in action so long as the loom is working, cracks, or missed picks, will be formed in the fabric unless the taking-up motion be reversed sufficiently before re-starting the loom.

To prevent the occurrence of such defects, the loom is provided with an expansion catch, which engages in the ratchet wheel, and is arranged so as to reverse the ratchet by from one to four notches, according to the adjustment, as soon as the pawl and check detent are lifted. When the loom is

re-started, the expansion catch falls back into its original position, ready for action when occasion again arises.

Notwithstanding the acknowledged utility of this mechanism, looms are still found in which it is conspicuous by its absence.

Warp Tension and Warp Beam Brakes.

The warp beam revolves in bearings on the frame at the rear side of the loom, and is either provided with a brake, or else the beam pulleys are arranged so as to also serve the purpose of brakes.

Brake cords, fastened at the lower ends to the back traverse of the frame, are slung over the brake pulleys, the other ends being attached to weighted levers mounted on the walls of the frame. Iron chains may be substituted for cords, but are less frequently employed, on account of their tendency to abrade the pulleys, although they ensure a more accurate regulation of the warp beam in the case of very delicate fabrics.

The cords may be wound round the brake pulley one, two, three, or (more rarely) four times, according to the requirements of the goods. If too many turns are given, the pull exerted by the weighted lever against the further end of the cord ceases to operate, so that when four turns are given to the cord, three only are in tension, the fourth being slack.

Should three turns prove insufficient to produce the required tension, it is better to increase the pull by sliding the weight to the extreme end of the lever; and if this does not suffice, heavier weights should be employed. As a rule, the weights supplied with the loom will answer the purpose, except for heavy goods subjected to heavy strokes in beating up.

In order to prevent smashes, the warp is preferably subjected to the minimum tension possible. On the other hand,

insufficient tension also leads to warp smashes, because then the weft does not enter the fabric in the same ratio as the latter is taken up by the grooved roller.

To ascertain whether this defect is being produced, the lathe is moved to its foremost dead point, and notice is taken whether at this instant any folding of the fabric occurs in front of the reed. Should such be found to be the case, more tension must be given to the warp to facilitate the better beating up of the weft. This being an important factor in protecting the warp, attention is especially directed to the matter.

Attaching the Warp at the commencement of Weaving.

The warp having been placed in the loom ready for the commencement of weaving, it is fastened in the following manner:—

Four, five, six, or a larger number of cords are slung on the cloth beam, and to the ends of these an iron rod is attached in a position near the reed. A portion, about 5 centimetres (2 inches) wide, is taken from the centre of the warps, after the same has been carefully adjusted to a uniform tension for each thread throughout, and is tied to the iron rod. An equal portion at either edge of the warp is next treated in the same way, and so on until all the warp is fastened.

In other cases, knots can be made in portions of equal size, and the iron rod inserted therein.

At the commencement of weaving, the shed must be carefully divided by hand for a few picks, and any loose threads brought to the proper tension.

Weaving then proceeds until enough cloth has been formed to pass once round the cloth beam, whereupon the cords are removed, and the end of the piece of cloth is fixed by means of a rod of wood or iron, which fits into a groove in the

beam. On winding up the cloth, the pressure of the beam against the taking-up roller comes into play.

Preventing Loops in the Weft.

In the case of multiple-shuttle work the formation of loops of weft at the selvedges is likely to occur, either as a result of overtwisting yarns, or unequally twisted wefts, or through the rebounding of the shuttle, a contingency to be above all things avoided.

It is a good plan to pack a little waste thread or wadding in the hollow by the eye of the shuttle in order to act as a brake on the weft thread. Another method is to draw a few short threads through the shuttle eye, in the form of a tuft, and to fasten them inside the shuttle either by the aid of a pin or by a small wooden peg driven into a second hole near the eye through which the thread ends are drawn.

When such devices are resorted to, it is preferable that the shuttle should not run quite out before a new cop is inserted, but that the ends of the two weft yarns should be twisted or knotted together, drawing-in with the mouth, or by means of a hook, not being easy to effect properly.

In silk looms the shuttle is often fitted with a small appliance for suitably checking the silk weft. Where this is not used, it is customary to take a small piece of felt covered with fine fur, the same being glued inside the shuttle so that the silk thread passes over the fur in leaving the shuttle.

Revolving Box Looms

are generally divided into two classes:—

(*a*) Simple,
(*b*) Eccentric;

these again being subdivided into single action and double action according as the boxes are fitted to one side of the loom only or on both sides.

The eccentric revolving box is almost entirely mounted on one side only (single action). Each barrel is constructed to hold six shuttles.

Single Action Revolving Box Motion.

On the outside of the frame is mounted an eccentric which, in rotating, imparts an oscillating, rising and falling motion to a horizontal draft lever. The picking shaft makes one turn for every two picks, and consequently the eccentric only acts on the draft lever at the same rate, so that the boxes are changed only after the 2nd, 4th, 6th, 8th, 10th picks, and so on.

A screw bolt attached to the frame carries two fingers, each of which is provided with a stud at its upper extremity and actuated by a cam on the cam shaft in such a manner that a vertical rod lifts and lowers the stud ends at every second pick.

If the perforated pattern card on the cylinder is in such a position that the pattern hole is on the left hand side, then the corresponding stud and the upper end of that finger remain down, while the other end presses the hook—which has a vertical motion—against the nose of the oscillating draft lever, and is lifted thereby, the result being that the turning catch, attached to the hook by a lever, causes the box mechanism to turn towards the left for a distance equal to one box. In a similar manner a second arrangement of levers turns the box mechanism towards the right hand when the hole is on the right hand side of the card. Consequently in this motion the change of boxes can only be effected after an even number of picks has been inserted.

Pick-and-pick Revolving Box Motion.

In external appearance this motion resembles the one just described. The eccentric on the cam shaft is, however, in

this case double, on which account the oscillating draft lever is raised and lowered after each pick. Moreover, the cylinder moves forward at the rate of one card after each pick, and consequently the number of picks can be either odd or even.

The cylinder is pierced by four holes, two of which—the left—are for the left revolver, and the two on the right hand for the right revolver.

Two connecting rods, extending from one side of the loom to the other, across the back, act upon the hooks on the far side, which are raised and lowered by the oscillating draft levers at each pick.

In all these revolving box motions, however, the boxes can only be moved forward one step at a time, a limitation which must be borne in mind in considering their capacity for weaving any particular pattern.

Eccentric Revolving Box Motions.

This class of box motion presents a considerable advantage over those described above, in that it enables two or three boxes to be moved to the left or right at a time, and therefore renders possible the weaving of more complicated patterns than the others.

In general features the arrangement of the mechanism corresponds with that in the single revolving box motion.

The eccentric, which is provided with five projections, is cast in a single piece, and is attached to the cam shaft by a couple of set screws. The first projection actuates the vertical sliding rod or fifth bracket lever; the second works the mechanism when a right- or left-handed change is required, as well as releasing the presser and the two detents; the third moves two boxes forward; the fourth, three boxes; and the fifth comes into action when a single box is to be moved.

There are four horizontal draft levers, and six hooks are required, the latter being employed as follows :—

The first, counting from the frame of the loom, serves to turn the revolver to the left, the second serving the converse purpose, *viz.*, turning to the right; the third is caused, under the influence of either of the two others, to engage—by means of the iron plate attached to the hook head—in the draft lever each time a box is changed, and serves to release the two detents—which are connected together by a spiral spring—and to draw back the presser from the star, *i.e.*, release the appliance which maintains the shuttle-box in an accurate relative position towards the lathe. The fourth hook turns two boxes; the fifth, three; and the sixth, a single box.

Five bracket levers, each provided at the upper end with a stud, are employed, on which account the cylinder or pattern card contains five stud holes.

The following rule prevails in the weaving of change patterns :—

Starting from right to left, the first hole in the card gives a left turn; the second a right turn; the third moves two boxes at a time; the fourth, three boxes; and the fifth, one box.

If, for example, a single box is to be moved to the left, the card must contain the holes, Nos. 1 and 5.

Practical Hints in Mounting Revolving Boxes.

For turning the box barrel, a vertical rack is provided, which is connected with the hook lever or the three change hooks.

Now, care must be taken in the first place, that all six hook heads stand at an equal height, and in such a manner that the space between the hook noses and the catches of the draft levers at the moment when the latter are depressed

as far as they will go, is equal to $\frac{1}{6}$ to $\frac{1}{5}$ of an inch, this distance being easily adjusted by raising or lowering the individual parts.

If at this instant the rack is pressed against the pinion, the second and third teeth of the former (underneath) must completely enclose one of the teeth on the latter. This adjustment is controlled by a screw thread on the lower end of the rack.

The proper contact between the teeth of the rack and pinion should be looked after, in order to prevent any slipping of the cogs. Two teeth are moved to advance the barrel one box, four teeth correspond to two boxes, and six to four boxes.

In fixing the eccentric in position, the following operations are performed :—

The crank shaft is turned on top centres. At this instant it must be assumed that the shuttle has completed its course through the shed, so that the changing of the boxes can be commenced. For this purpose the projecting portion of the eccentric should make contact with the bowl of the bowl lever, so that, on the slightest forward movement of the loom, the bowl lever will instantly be lifted and the changing begun.

When it is evident that the bowl is exactly on the centre of the eccentric, the set screws are tightened up.

In single revolving box motions, it should not be overlooked that in screwing up the eccentric, the loom is so adjusted that the stroke for the ensuing pick is effected from the box side of the loom.

If any difficulty should arise in the changing of the boxes, whether through the jamming of the picker or the shuttle, a smash would be inevitable. To prevent this, however, each box mechanism is fitted with a coupling which, in the case of the ordinary revolving box motions, is attached to

the horizontal draft levers, but in eccentric motions consists of two strong flat vertical springs, pressing on two bearing faces on the draft lever.

Occasionally it may happen that, without any jamming of picker or shuttle, the change of boxes is not effected with accuracy, but only half way. This is due to excessive tension of the spiral spring, which pulls back the hook lever attached to the rack, the result being that the draft lever is overtaxed and drawn out of the coupling at each change of boxes. This can only be observed at the instant the change is being effected, the coupling returning to its proper position immediately.

The tension of the spiral spring should be just sufficient to draw the rack upwards into position.

The revolving motion may also get displaced when the picker is very much worn, and the shuttle in consequence lays far back. The result of this is to make the changing of the boxes much more difficult, the coupling yields, and the catch of the draft lever is unable to effect the lifting of the hook.

When this occurs, the shuttle must be induced to rebound a little by lengthening or shortening the check strap or flattening the springs in the shuttle box ; or else a remedy is sought by turning the picker end for end, or replacing it by a new one.

An excessive rebounding of the shuttle must be carefully avoided, or smashes may very easily result. It is highly advisable to number both the boxes and shuttles, so that a shuttle may always be returned to its own box.

Reed Protectors (*Loose Reed Motions*)

consist of appliances for withdrawing the reed towards the back of the loom on the advance of the lathe, if a shuttle be jammed in the shed. They are employed almost exclusively

in looms fitted with revolving box motions, and are arranged as follows :—

The cap of the lathe is hollowed out for the reception of the reed, which hangs loosely therein, being held fast, however, against the race during the motion of the lathe by a cross rail of wood or iron screwed on to arms working on a pivoting shaft below the lathe block. The pressure of this rail is caused by the tension of two spiral springs attached to the pivoting shaft and the foot of the lathe, and it thus becomes evident that when the advancing reed comes in contact with a jammed shuttle in the shed, the resulting pressure causes the springs to yield and the rail to describe an arc towards the rear, thus enabling the reed to fall back.

If the fabric were beaten up with anything approaching a strong pressure, this arrangement would result in the reed giving at each stroke were it not for a pair of arms mounted on the pivoting shaft and pointing forwards, which arms, during the operation of beating up, come in contact with corresponding buffers screwed on to the breast beam, and thus hold the reed fast. The buffers must be so adjusted that when the lathe is at its nearest point in relation to the breast beam the two arms slide about $\frac{4}{5}$ of an inch below them. No pressure should be exerted, or a smash might easily result.

Dobbies.

The dobby presents the advantage over the tappet loom of enabling weaving to be produced with as many as 24 shafts and an unlimited number of picks.

Nevertheless, it must be remembered that treadle looms, by reason of their simplicity and higher speed, manufacture fabrics with a minimum of faults, and are more productive.

All the parts necessary in treadles are dispensed with

in dobbies, and the lifting of the shafts is effected singly. Of the various systems of dobbies, a few will now be discussed.

The Hodgson Dobby.

Although simple in appearance, this dobby often gives rise to difficulties when being set by persons unaccustomed to its use, in consequence of which circumstance it is likely to be mistrusted at first, whereas it is in reality one of the best of machines.

The dobby mechanism is mounted at the head of the loom, and the shed is an open one, the shafts which are to be lifted during two, three, or more picks remaining all the time at the same height.

Although drawing-in, in case of smashes, is more difficult, since a complete closing of the shed does not occur, this method is advantageous from the point of view of warp protection. As the machine is negative in action, and only lifts the shafts, an under motion of spiral springs has to be provided below.

The construction is simpler than almost any other machine. The shafts are suspended from bracket levers connected with the hooks by hinges.

Whilst in narrow looms one set of shaft levers is sufficient, two sets are required for wide looms, and are connected by draft hooks.

The peculiarly shaped knives, which receive motion from the picking tappet shaft, are placed horizontally, and move backwards and forwards in a slot in the frame of the machine. The tappet is of the same shape as that of a plain-weave loom, and there are two treadle plates parallel to the frame and fitted with treadle bowls which make contact with the tappet.

A belt is attached to one end of both treadle plates and

passes over an intermediate pulley, so that the one lever is lifted automatically when the other is depressed by the action of the tappet.

Draft rods connect the treadle plates with the slotted levers resting on the knives, and since the tappet makes only one turn during two picks, it is easily understood that in each revolution of the loom the knives are moved alternately, first one and then the other, backwards and forwards.

At the ends of the hooks noses are placed, one pointing upwards, the other downwards, fitting in catches on the knives, and another nose is situated in the centre of the under side of the hooks.

Under the hooks are placed small intermediate levers mounted on a pin, and these rest on the lifting studs for working the cylinder. The action of these levers is to support in their raised position the shafts which are to remain lifted during two or more picks. This circumstance must be particularly recollected in setting the machine to work, and the hooks must be drawn so far away from the knives as to enable the small intermediate levers to engage in and retain the central nose pieces on the former when occasion arises.

To adjust the eccentric for the knives, the loom is turned so that the cranks on the crank shaft are on back centres, whereby it is assumed that the shafts are to be lifted. For this purpose not only must one of the projections of the eccentric point to the centre, *i.e.*, the dead point on the bowl of the shaft lever, but also the eccentric should be turned about $1\frac{1}{5}$ inches to the front, in order that the change of shed may begin a little before the beat of the lathe on the goods commences. The adjustment of the eccentric is effected by a couple of set screws.

The draft rods are now attached to the levers, and are lengthened or shortened by means of the screw threads with which they are provided, so that the distance between the

middle nose of the hooks and the small intermediate levers is about $\frac{1}{5}$ of an inch, as already stated. The shed can be opened wider by moving the bolts in the slotted levers towards the machine, or narrowed by moving them in the opposite direction. The resting point of the shafts in their lowest position is found by laying the shaft lever on the frame of the machine.

The cylinder is actuated by a cam mounted on the crank shaft, and must be so adjusted that when the loom is in the position named and a blank card is placed on the cylinder, the small intermediate lever is raised by the stud and engages with the middle nose-piece on the hook, *i.e.*, the eccentric must be at the bottom dead point. The requisite adjustment is effected by the draft rod, and the eccentric can also be moved forwards or backwards as desired.

The cylinder should not press on the lifting studs, or holes will be made in the cards.

In this machine there are also two turning catches, one acting on the cylinder and the other engaging in the lantern and preventing the cylinder from turning too far.

The shaft levers on which the shafts are suspended are fitted with notches, in which are fastened cords attached to ringbolts screwed in the wooden levers placed between the shaft levers and the shafts. Since the screws are inserted slantwise in the wooden levers, a sloping shed is produced, *i.e.*, the rearward shafts are lifted higher than those in front, on which account the cords can be slung perpendicularly on the shaft levers.

Card Motion of the Hodgson Dobby.

For the movement of the cards in this machine a special apparatus is necessary, and as the operation is attended with greater difficulties than in other machines, the working of the several parts will be fully explained.

Position of all the parts for the motion of the hooks for the first pick :—

All the shaft levers are depressed and the hooks are therefore not drawn upon. Card No. 1 is pressed on to the lifting stud, and as the card perforations correspond to all the shafts in the weaving that are not affected by the first pick, the hooks relating thereto remain lowered, whilst those corresponding to the unperforated parts of the card are lifted.

The upper knife stands in position ready to engage with the lifted hooks, whilst the lower knife is drawn out and leaves the lowered hooks untouched.

On now setting the loom in motion the raised hooks are carried along by the upper knife, *i.e.*, the shafts are lifted, whilst the lower knife travels empty. The upper knife being then withdrawn, the shed is made, and is ready for the insertion of the first pick.

Position of the parts for engaging the hooks for the second pick :—

Whereas by the movement of the loom the upper knife has now been drawn out of gear, the lower knife is ready to engage for the second pick. The cylinder also has made one turn in the interim and No. 2 card is already in place on the stud. This card contains perforations corresponding to all the changes to be made from the first pick, and hence the following result is obtained :—

For those hooks or shafts that were raised or lowered for the first pick and are not to be moved for the second pick, there are no holes on the card, hooks that are to remain lifted being held by the middle nose by means of the lifted studs and intermediate levers, and thus prevented from descending with the others. Moreover, the hooks which, as in the first pick, are to be left untouched, are also, in their disengaged condition, lifted by the studs and allow the lower

knife to retreat below them, so that the shafts still remain down.

On the other hand, for hooks which were low for the first pick and are now to be lifted for the second, the card is perforated; the studs and hooks consequently remain low and are lifted by the lower knife.

Finally, other holes in the card correspond to the hooks which were lifted for the first pick and are to be lowered for the second. The lifting studs therefore remain low, and as the hooks are not restrained, they are able to descend with the upper knife.

The lower knife having been drawn out for the second pick, all the shafts corresponding to the marked squares of the pattern will be in the raised position.

At the same time the No. 3 card and upper knife will be in action, and whilst the perforations in the card allow all the corresponding hooks to recede, the blank places on the card give opportunity for the hooks to be engaged by the upper knife, and lifted ready for the third pick. Simultaneously the raised hooks from the second pick are brought down by the under knife into the bottom shed.

From these particulars the following rule may be established:—

The upper knife lifts for the first pick all the shafts that correspond to blanks in the card, *i.e.*, all the marked squares of the pattern, and, by means of the action of the intermediate levers before it is withdrawn, enables the lifted shafts, which are to form part of the succeeding top shed, to remain in position.

For the completion of the second pick, the lower knife lifts the shafts corresponding to holes in the card into the upper shed, and leaves behind the others which are required to supplement those drawn down by the upper knife in completing the bottom shed for the second pick.

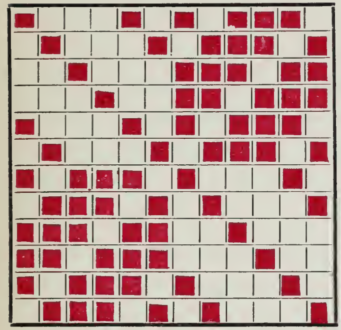
It will thus be understood that only even numbers of cards can be used in this machine; hence patterns with an odd number of picks to a repeat require double that number of cards.

The following condensed rules for the card motion may be given: Cards 1, 3, 5, 7, etc., contain all the blanks of the combination, whilst in Nos. 2, 4, 6, 8, etc., the holes refer to the changes required since the preceding pick.

To enable this to be more readily understood, two weavings with the corresponding pattern cards are reproduced below, one with an even number and the other with an odd (and therefore doubled) number of picks to a repeat:—

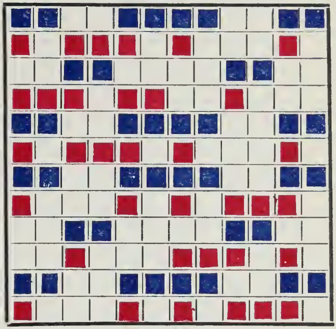
1*a*.

ACTUAL WEAVING.



1*b*.

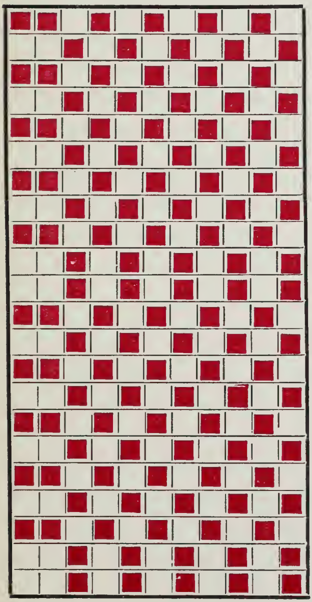
PATTERN CARD.



12 SHAFTS.
12 CARDS.

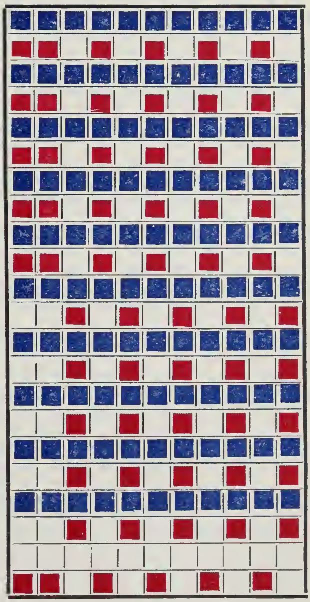
2*a*.

ACTUAL WEAVING.



2*b*.

PATTERN CARD.



11 SHAFTS.
22 CARDS.

The even picks for the lower knife are coloured specially, in order to render the blocks more intelligible. Red and blue are punched, and it is evident that a card may be all blanks or all holes.

It is also advisable to have the cards of different colours, *e.g.*, white for the odd, and blue for the even numbers. An unskilled puncher will do well to first extract the pattern card from the weaving combination, but for a skilled worker it is not difficult to punch first the odd cards, and then the even cards, direct from the weaving.

The employment of cards of different colour presents the advantage that, if the weaving is interrupted, it can be ascertained at once which cards are to be set for the one or the other knife. A wrong card would lift all shafts, none at all, or else the wrong ones; in this event, all that is necessary is to move the cylinder forwards or backwards one card, the white cards being intended for the upper, and the blue ones for the lower knife.

When it is desired to weave on simple change-box looms such combinations wherein at any given point, two, four or more picks of a different colour or kind of weft are required, care must be taken, if this decoration is down on the design to commence at an odd-numbered pick, that the upper knife lifts the same shafts as soon as the pick occurs from the side on which the change box is placed.

If in the case mentioned, the lower knife were to draw the shafts, the combination would need altering to make the decoration commence with an even numbered pick, or else the eccentric actuating the dobby must be moved round 180° on the shaft. The latter method is decidedly preferable, and care should be taken in mounting the machine, that the upper knife lifts as soon as the pick occurs on the side on which the change box is situated. When the loom is adjusted in this manner, the combinations must be so arranged

that all changes of weft begin at odd numbered picks, since otherwise faults will be produced. This rule does not apply to goods not requiring the insertion of differently coloured or constituted wefts.

The Hattersley Dobby,

by reason of the quiet and accurate manner in which it works, is highly esteemed and finds extensive employment, especially in the production of clothing stuffs.

Whilst for narrow looms the shaft levers contained in the machine are sufficient, wide looms require a jack on the top frame for supporting a second set of shaft levers. The connection with these shaft levers is effected by means of draft rods.

The new arrangement of 2-shaft levers directed outwards from the centre of the frame, where they mutually engage by means of rackwork, is particularly advantageous for narrow looms, and enables the best and most convenient shed formation imaginable to be produced, inequality or variability of lift, such as often occurs in simple-shaft levers, being here absolutely precluded. In place of the ordinary shaft levers fitted with notches, there are only bracket levers without notches, connection with the shaft levers being effected by short hooked rods.

Each bracket lever is connected with two superimposed horizontal hooks, so that a 16-lever machine contains 32 hooks.

Below the single catch hooks two knives move in slots provided in the frame, each knife serving for 16 hooks. The knives are connected with a 2-arm and 3-arm lever, mounted on the same shaft, the latter lever being joined by a connecting rod to an adjustable crank attached by screws to the picking tappet shaft. The crank makes one revolution for each two turns of the loom, and thus draws out one knife or the other alternately at each pick.

The pattern cards consist of wooden lags, and each lag, being intended for two picks, contains two longitudinal rows of holes arranged alternately; the lags for a 16-shaft machine having two rows of 16 holes each, one set for the lower hooks, the other for the upper ones.

Above the pattern card are 32 intermediate levers, each pair of which belongs to a separate shaft lever. Wooden pegs are fitted in the lags to raise the levers destined to be lifted for the pick, and as the finger for moving the cylinder ratchet is placed on the lower part of the 3-arm lever, the cylinder is moved forward on the retreat of the lower knife. The pegs in the first row of the lag now lift the intermediate levers, the opposite ends of which, together with the corresponding hooks, descend, whereupon the latter are engaged by the lower knife and drawn out thereby.

A series of vertical needles rest on the intermediate levers working the upper hooks, and effect the descent of such of the hooks as correspond to the pegs in the second row on the first card. The lower knife is now drawn out of gear, whilst the upper one is already in action for the third pick, and so on.

Now, since two picks come upon one card, only such combinations as have an even number of picks can be used, unless a double number of cards be employed.

In starting the Hattersley dobby on a single change-box loom, the following points must be borne in mind:—

When the pick has been effected from the side opposite the change box the lathe is set on back centres. The crank mounted on the tappet shaft and driving the dobby mechanism must now not only point directly downwards parallel to the draft rod, but also be drawn a little ($1\frac{1}{4}$ to $1\frac{1}{2}$ inches) forward and fixed by the screws.

If now the loom be turned back to the dead point of the machine crank, the lower knife should be within $\frac{1}{5}$ of an inch

of making contact with the noses of the hooks. At the same time the ratchet finger must already have moved the cylinder forward.

On next setting the loom in forward motion the lower knife will lift the shafts for the first pick, and the pick will follow from the change box side.

When the lower knife is withdrawn, *i.e.*, when the crank is on top centres, the upper knife will already be in contact with the hooks for the second pick, and in this case also the distance between the knife and the noses should be $\frac{1}{5}$ of an inch.

While the upper knife is lifting the shaft for the second pick and the pick is being effected from the opposite side to the change box, the lower knife is already retreating; and as the cylinder is being moved concurrently, the second card—*i.e.*, the third and fourth picks—is coming within the reach of the intermediate lever, to enable the shafts to be moved again, first by the lower and then by the upper knife alternately.

Here, as with the Hodgson dobby, the shed is never entirely closed, since the shafts which are to remain lifted during several picks are, at the same instant that they should be brought into the lower shed by the one knife, lifted by the other. Consequently this machine also belongs to the open-shed class and enjoys the consequent advantages of high speed and quiet working, combined with the preservation of the warp.

To enable the shed to be adjusted (opened wider or contracted) the crank is slotted, the screw pin being moved towards the centre to reduce the aperture of the shed, or away from the centre to open same. After such adjustment has been made the draft screws on the knives must be loosened and the machine crank brought first to the one dead point (by turning the fly wheel) in order to adjust the

one knife to within $\frac{1}{5}$ of an inch of the hook noses as before; after which the other knife is fixed in the same way, the crank being first brought to the opposite dead point.

If the draft screws are not first loosened danger is incurred, in the adjustment of a larger shed, of the knives pressing in the slots when the loom advances, whereby smashes are liable to ensue.

Should the shafts be wrongly lifted, or left behind after the machine has been set in the prescribed manner, the cause is to be sought in the card pins not being properly adapted to the intermediate levers, a defect remediable by adjusting the cylinder a little. In the case of lags the pegs may have become worn or out of shape, or iron pins may have been set askew, thus causing the same defect.

In concluding this description it may be briefly remarked that: When the pick is effected from the change box side, the shafts must have been lifted by the lower knife, whilst in the second pick the lifting of the shafts by the upper knife coincides with picking from the side opposite the change box.

In weaving combinations where two, four, six, or more picks play a special part by means of other weft yarns, it is advisable, in setting the crank, to make the design commence (as in the Hodgson dobby) on an odd number pick, and finish on an even number, particularly as each card is destined for two consecutive picks.

To prevent the Shafts from Swinging.

Without the adoption of some special contrivance it is impossible to keep the shafts of single-shaft dobbies (for narrow looms) from swinging while at work. For this purpose the shaft cords are passed over rollers mounted on the upper frame, or else guide racks are attached at both ends of the shaft rods, to steady the individual shafts.

Although the said rollers keep the shafts from swinging,

they fail to make the lower shed steady; and though the guide racks may be so mounted that the shafts of the bottom shed rest thereon, this cannot be carried out, the result being a continual concussion while the machine is at work. Moreover, a considerable though varying amount of friction ensues between the rods and the guides, and, as they are tightly coupled, the repairing of a broken selvedge is rendered difficult. Consequently, neither of the above-named methods can be considered satisfactory.

On this account the author has made attempts to attach the shafts in such a manner that all these defects are obviated; and he finds the following method answer well:—

Two flat iron rails provided with a separate hole for each shaft are used, each rail being bent over at an angle at the ends, and attached to the top frame by screw pins passing through holes in the angle pieces. The rails occupy a position exactly over the harness screws, and the holes in the rails enable each separate shaft to be suspended by double cords, which are tied on to a length of stout wire above the rail. By this means the relative height of the shafts can be adjusted at convenience.

In addition to entirely obviating the swinging of the shafts, this method enables them to be readily separated by hand when a selvedge has to be tied up, and also affords a convenient means of perfecting the arrangement of the top-shed shafts, by drawing up the cords, without prejudice to the bottom shed.

The Wenzel "Triumph" Dobby.

This recently introduced machine is made by C. A. Roscher of Georgswalde; the shed formation is of the top-and-bottom order, on which account the threads can be conveniently drawn in when the shed is closed.

In this dobby the turning of the cylinder is effected only

when there are more than six picks to a repeat, as patterns up to six picks require only a single card.

The adjustment of the needle board is effected by a tappet which can be changed in accordance with the weaving combination.

3-pick	fabrics	need	1	card	and a	6-section	tappet.
4 ,,	,,	,,	1	,,	,,	4	,,	,,
5 ,,	,,	,,	1	,,	,,	5	,,	,,
6 ,,	,,	,,	1	,,	,,	6	,,	,,
8 ,,	,,	,,	2	,,	,,	4	,,	,,
10 ,,	,,	,,	2	,,	,,	5	,,	,,
12 ,,	,,	,,	2	,,	,,	6	,,	,,

A linked chain and connecting gear serve to actuate the cylinder, one link of the chain being advanced for each revolution made by the tappet.

The chain passes over a guide roller in the immediate neighbourhood of two fingers, and the links are so constructed that when the one end is turned upwards it acts on one of the fingers, and on the other when the other end is turned. These fingers cause the upper and lower turning hooks to engage with the lantern on the cylinder, motion being imparted to both knife and çylinder by an eccentric mounted on the crank shaft.

This machine is specially adapted for bordered weavings, serviettes, towels and so on, the saving in cards being very considerable. The action of the individual links will be explained below, and it should be noted that when a "loom with machine left" is mentioned, the position behind the loom is meant, whilst in "looms with machine right" the position in front of the loom is implied.

A link turned upwards on the left side turns the cylinder backwards (down) by means of the lower hook, and a link turned upwards on the right side moves the cylinder forwards (up) by the upper hook. A link, neither side of which is

turned upwards, leaves the cylinder at rest, and causes the same card to repeat.

The Warp-treadle Mechanism of the Honegger Silk Loom.

In order to protect delicate silk fabrics from contamination with oil, the shaft mechanism is situated at the side of the loom instead of overhead, the treadle arrangement being simple, and attached to the floor on the side opposite to the driving gear.

A cylindrical roller for the pattern cards is mounted on two frame walls, and also carries an 80-tooth cone wheel, engaging with a 20-tooth cone wheel on the tappet shaft.

During a semi-revolution of the picking tappet shaft, or one pick, ten teeth of the small wheel, and, therefore, ten teeth of the larger wheel, or $\frac{1}{8}$ of the total, are moved; and as the cylinder is arranged to take at least eight cards, each card corresponds to a pick.

The cards consist of strong wooden lags containing holes for the reception of small nuts, and joined together by iron links. A number of small castings of special form are screwed on the lags in such order that each casting corresponds to the lifting of a shaft, in accordance with the pattern.

Above the cylinder are placed 16 shaft bowl-levers, mounted on a rod; the bowls move over the castings as the cylinder revolves, and cause the shaft lever on the opposite side to rise and lift the shaft. Where no casting is present, the corresponding shaft remains down.

The shaft levers are grooved for the reception of draft cords, which are connected with wooden shaft levers placed above the loom. The opposite end of the wooden shaft lever is situated exactly above the centre of the loom, and from here other cords, passing over wooden rollers, are connected with the harness.

The first cords should be provided with loops, in order to enable the height of the shed to be adjusted. By slipping the cords into a groove nearer the end of the lever, a wider shed is produced and *vice versâ.* The reversal of the shafts is effected by means of springs attached to the flooring.

In fixing the cone wheels, the loom should be turned so that the cranks of the crank shaft are on top centres, at which moment the castings for lifting the shafts must engage with the bowls on the levers.

A separate lever enables the shafts to be lifted out of reach of the pattern card, thus locking the shafts and facilitating the drawing-in of broken threads, etc.

Jacquards.

The Jacquard is resorted to for patterns requiring a number of picks to a repeat beyond the capacity of the dobby.

This machine was invented in 1805 by Charles Marie Jacquard, a Frenchman born at Lyons, on 7th June, 1752, of poor parents (weavers), and brought up without any school education. At an early age he occupied himself with mechanical contrivances, and, when ten years of age, he learned to read and write unknown to his father (his mother being then dead).

Subsequently he took up book-binding, and when twenty years of age—his father having meanwhile died—he returned to the completion of his early ideas and devoted himself to weaving; but his undertakings proving disastrous, he got in debt and was obliged to earn a bare subsistence by working in the gypsum quarries at Bugey near Lyons.

Many years later, and after a hard struggle for existence, he succeeded, in 1799, in constructing a machine for which he received the bronze medal of the Paris Industrial Exhibition. He occupied himself in perfecting his invention, and, finally, by borrowing various mechanical devices from the

loom made by the renowned mechanician Vaucanson, the Jacquard machine was completed.

When sixty-seven years of age Jacquard, satisfied with the success that crowned his labours, retired from public life to his estate at Oullins, near Lyons, and died there on 7th August, 1834, at the age of eighty-two.

The Jacquard machine is made in any convenient size, the hooks rising by hundreds from 100 to 2500, though the size most in use, especially for power-looms, has 400 hooks. The distribution is classified into "coarse" and "fine," and latterly into "fine-fine" and "finest" as well. The distance between the centres of the holes amounts to :—

In the coarse	6·25	millimetres.
,, fine	5·78	,,
,, fine-fine	5·85	,,
,, finest	2·85	,,

In a "coarse" machine one hook for each tier or 2 °/₀ of the total is provided as reserve. Consequently—

A 200-hook machine with	4	tiers has	204	hooks.
,, 300	,,	6	,,	306	,,
,, 400	,,	8	,,	408	,,
,, 500	,,	10	,,	510	,,
,, 600	,,	12	,,	612	,,
,, 700	,,	14	,,	714	,,
,, 800	,,	16	,,	816	,,

In the finer machines the needles are closer together, and a larger number—at least 10 °/₀ more—of reserve hooks is provided. Thus—

A 200-hook machine with	55	rows and	4	tiers has	220	hooks.
,, 300	,,	55	,,	6	,,	330	,,
,, 400	,,	55	,,	8	,,	440	,,
,, 500	,,	55	,,	10	,,	550	,,
,, 600	,,	55	,,	12	,,	660	,,
,, 700	,,	55	,,	14	,,	770	,,
,, 800	,,	55	,,	16	,,	880	,,

A	1000-hook machine with	82	rows and	14	tiers has	1148	hooks.
,,	1200 ,,	82	,,	16	,,	1312	,,
,,	1600 ,,	110	,,	16	,,	1760	,,
,,	2000 ,,	164	,,	14	,,	2296	,,

The larger machines are divided, the card prism being arranged for two sets of cards; or else the machine is duplicated, the idea being to dispense with an excessively large prism, on the one hand, and, on the other, to protect the knives from breakage.

In the Lacasse (fine) machine (French system) the hooks occupy three-fourths of the total space of the machine :—

A	400-hook machine contains	440	hooks.
,,	500 ,,	544	,,
,,	600 ,,	656	,,
,,	800 ,,	880	,,
,,	1200 ,,	1320	,,
,,	1600 ,,	1760	,,
,,	2000 ,,	2200	,,
,,	2500 ,,	2640	,,

In the machines ("finest") of J. Verdol & Co., the even cross rows are disposed diagonally half way between the other holes. The cards are formed of an endless band of paper.

A	600-hook machine contains	672	hooks.
,,	800 ,,	896	,,
,,	1200 ,,	1344	,,
,,	1600 ,,	1792	,,

Most of the reserve hooks are intended for selvedges, borders and so forth.

Jacquards are constructed of iron, wood; or the machines of iron, and the hooks of wood.

The Single-lift Machine (English System).

This machine is mounted over the loom in such a manner that the prism is parallel to the cord board, and towards the

rear, so that the harness has an open appearance, and is consequently termed "open" or "English harness". It can be used for right or left looms, and is actuated by means of a draft rod from an eccentric disc on the crank shaft.

The frame is of iron, the hooks of wire, and the bottom board, prism, needle board and spring box of wood.

A separate eccentric on the crank shaft drives the prism just as in a double lift machine, the fly wheel being suitable for this purpose if provided with a slot.

In setting the machine, the reed must be brought to about $\frac{1}{3}$ to $\frac{2}{3}$ of an inch in front of the foremost dead point. The fly wheel must be affixed to the crank shaft in such a position that the swinging rod points exactly parallel to the crank shaft, the crank pin being at the top. When this is done, the loom is turned forward a little until the knife ("griffe" bar) is in action just close in front of the bend of the hooks, the eccentric on the crank shaft being at the same instant in its lowest position, *i.e.*, the prism is pressed against the needles, and thereupon all the parts are properly screwed up. The pressure may be exerted so far as to sufficiently depress the needles and hooks without the prism coming in contact with the needle board.

Any pressure or "stamping" of the griffe bar box must be strictly avoided; hence, when the machine is closed the box must not rest on the bottom of same, but be separated therefrom by a distance of $\frac{1}{12}$ to $\frac{1}{8}$ of an inch.

Since all the motions of the machine proceed from the crank shaft, it follows that at each turn of the loom the entire mechanism of the machine makes one complete motion. The top shed is the sole basis of the shed formation.

The Double-lift Jacquard (English System).

Apart from the prism and the spring box, this machine is constructed of iron throughout. It contains a double number

of hooks, a 400-hook machine having 800, or 816 including the reserves, *i.e.*, in place of 8 sets there are 16. This also is a top-shed machine.

Each pair of longitudinal rows (tiers), *viz.*, 1st and 2nd, 3rd and 4th, and so on, correspond to a single tier of the ordinary Jacquard. Each needle is therefore fitted with two eyes, so as to work two hooks, and each pair of the corresponding hook cords are attached to a tuft of harness cords.

There are, moreover, two sets of knife grids, each containing eight knives, and these are so arranged that—

The first knife of the 1st grid,
,, ,, ,, ,, 2nd ,,
,, second ,, ,, 1st ,,
,, ,, ,, ,, 2nd ,, and so on,

together make sixteen knives.

The hooks are of wire, like those of the single-lift machine, except that the lower ends to which the cords are attached project at least so far below the bottom board as the lift of the machine necessitates. From the point of attachment of the cords the hooks are bent upwards, and are suspended from an iron rod above the bottom board. Consequently the latter must be pierced by as many slits as there are hooks to be inserted and guided therein.

Both grids are raised and lowered alternately by means of a couple of swing levers placed above the machine, and moved by connecting rods attached to a double crank on the tappet shaft. As this latter makes one revolution for every two picks, one grid is lifted for each pick, whilst the other is depressed, this action being alternate.

As in the single-lift machine, the prism is actuated from the crank shaft, and its function is to press on the needles at the moment when one of the grids is at its lowest and the other at its highest position.

To those who have not had the opportunity of becoming

intimate with this machine, it will seem strange that the prism can be pressed against the needles as soon as the hooks are lifted. This is, however, rendered possible by the long elastic wire hooks.

It will also be comprehensible that with an open shed those hook cords always appear loose which are lifted by a bunch of the others. Nevertheless, by reason of its slow, and therefore regular and accurate working, this machine is advantageously employed for very high speeds.

The position is precisely the same as that of the single-lift machine, the prism parallel to the cord board, in consequence of which the harness in this case is of the "open" order.

Unlike a contracted (German) harness the harness cords are not guided by a grid under the bottom board, and consequently in wide goods the harness has a tendency to swing, the result being an uneven shed at the ends. This affords an opportunity for the shuttle to miss some of the threads and thus gives rise to weaving faults (coils).

In view of this the author of the present work was induced in 1893 to take out a patent in England, Austria and Germany for a "harness guide" invented by him. Experts are agreed that this contrivance entirely obviates the above-mentioned defects, a perfect shed is produced and clean handsome fabrics. The usual slant of the hook cords is also obviated.

The Top- and Bottom-shed Machine.

These are of two kinds, *viz.*, those in which the whole of the movements are effected by a single draft rod from the crank shaft, and those with separate rods for the top and bottom sheds respectively.

The latter are more general for heavy looms, and an independent movement is also provided for the prism. In these machines the bottom board is movable, and whereas the

hooks for the top shed are lifted by the knife blade (griffe), the bottom board and hooks descend to form the bottom shed. Machines of the former class are generally built of iron, the others of wood.

Practical Hints in Starting Jacquards.

The adjustment of the draft rods is effected in all machines whilst the shed is closed. With this object the lathe is set to within $\frac{1}{3}$ to $\frac{2}{3}$ of an inch of contact with the fabric in order that the weft may be properly beaten up before the close of the shed. It is only rarely that the close of the shed and the stroke of the lathe are allowed to occur simultaneously; and if the last-named operation succeeds the other, then not only is the fabric irregular and improperly beaten up, but an extensive smash is likely to occur.

Whilst in top-shed machines the breast beam and draft beam are arranged on the same level and the selvedges must form a half shed underneath when the machine is closed, the selvedges in top- and bottom-shed machines must be on the same level as these beams—a circumstance to be borne in mind when the harness is being arranged.

In turning the prism particular care must be taken that the motion does not begin until the prism is at a sufficient distance from the needle board, since if commenced too soon the cards will stick against the needles and get torn.

On most machines the turning hooks are capable of adjustment in front and rear. Moreover the prism lathe (batten) must not move too far, or the cards and cords will suffer damage; and an excessive swinging of the cards does not look nice. When, however, this mechanism is independent the movement is under control and can be increased or diminished as found desirable.

Every Jacquard machine is fitted with a striking blade,

which slides close under the lantern and engages therewith when the latter is turned edge on, thus bringing it into its proper position and preventing the bending of the needles, otherwise inevitable if the edge of the prism, through defective turning, were to come in contact with them during the pressing motion.

One very important matter is the accurate position of the knife box when the machine is closed; this should have come to a complete standstill, and must not press, but be at a distance of about $\frac{1}{8}$ of an inch away. If this precaution is neglected, the machine will "stamp," and a smash of some of the parts will quickly ensue. Consequently, the draft rods are fitted with screw threads to enable such mishaps to be avoided.

In single-lift machines, when the lathe is in the described position, the eccentric actuating the machine from the crank shaft must be on top centres. After screwing this up, the loom is moved forwards until the hooks to be lifted are almost engaging with the griffe blades. At the same moment the resting hooks must be pressed back far enough from the blades, with which object the eccentric for driving the batten is adjusted to the bottom dead point.

In double-lift machines the following course is pursued. After the lathe, as already mentioned, has been put in position, about $\frac{1}{3}$ to $\frac{2}{3}$ of an inch in front of the fell, the lower griffe box is connected, by means of the draft rod, with the first crank of the double crank on the picking tappet shaft. To this end the crank must be screwed tight when the pin is on top centres.

The crank pin is mounted in a slot cut in the crank disc, in order that the angle of the shed may be made larger or smaller, by pushing the crank pin out from or drawing it in towards the centre. The next step is to adjust the nuts on the draft rod so as to lengthen or shorten the latter, until, as

already stated, the griffe box is in a position about $\frac{1}{12}$ to $\frac{1}{8}$ of an inch above its point of repose.

As the first box is now connected up, the second is next taken in hand, and the loom is turned so far forward that the double crank moves through 180 degrees, *i.e.*, the second crank pin is on top centres. The distance between centres of the first crank pin and the crank shaft is next measured off, and the second crank pin adjusted to exactly correspond, so that both pins are equi-distant from the shaft centre. The second connecting rod is then put in position and adjusted like the first.

To set up the prism, which is the next operation, the loom is turned until the lower knives engage in the hooks, though the latter do not as yet hang on the blades. This accomplished, the batten eccentric is set on bottom centres on the crank shaft, and all the parts are screwed up so tightly that the prism sufficiently pushes back the needles, *i.e.*, hooks corresponding to the blanks in the pattern card.

When the preceding operations have been performed with scrupulous accuracy, the proper interaction of all the parts may be regarded as certain to ensue. It should be noted that the term "dead point" implies that the line between centres is parallel to the corresponding draft or connecting rod.

The swinging levers on the Jacquard machine should have the same arc of movement above and below the point of suspension; if the movement on one side exceeds that on the other the machine will be unsteady.

In setting up the top- and bottom-shed machine the lathe is first put in the position already described, and in this case the machine will be entirely closed. The connecting rod for moving the bottom board is then attached, and where double cranks are employed the first crank pin must be set at the bottom dead point, the connecting rod for the griffe box

being then coupled on to the upper crank pin without altering the position of the loom. Care is necessary that the bottom board does not press upwards, but is allowed an intermediate free space of $\frac{1}{12}$ to $\frac{1}{8}$ of an inch. The same applies to the griffe box when at its lowest position or resting point.

Here the top or bottom shed can be moved to a larger or smaller extent, and the crank pins do not need to be exactly equi-distant from the shaft centre, though this does not tend to increase the durability of the warp. In double-lift machines, irregularity in setting the crank pins makes an uneven shed.

To increase or diminish the aperture of the shed the connecting rods are adjusted as previously described.

The accurate adjustment of the prism is a matter of the utmost importance to the lifting action of the Jacquard. For this reason a trial is made by applying a little colour to the points of the needles and then putting a card on the prism and setting the latter in motion. By this means it can be seen at once whether the prism requires adjusting higher, lower, or laterally.

Mounting English Looms.

The end frames having been joined together by means of the cross frame traverses, the two connecting pieces for the central bearing are placed in order and the accurate parallelism and horizontal position of the various parts of the frame are ascertained by the aid of levels, etc., any inequality due to irregularities in the flooring being rectified by the insertion of suitable underlying supports.

The two picking tappets—and treadles, in the case of inside-treadle looms—are slipped on to the picking tappet shaft and the latter fitted in its bearings. The crank shaft is then put in place, and it is well to fix the two vertical picking shafts at the same time, their position being determined by

screwing the nose-piece in the centre of the picking tappet slot and keying the tappet temporarily on the shaft. The striking nose must point fully towards the striking roller, though not further towards the frame wall than corresponds with its own thickness. At the same time the roller must lay flush against the nose-piece and not against the edges of same.

The next step is to connect the picking tappet shaft with the crank shaft by means of the train of cog wheels, as follows :—

After keying the pinion on the crank shaft the lathe is turned to bottom centre, and the lower large toothed wheel is keyed on so that the striking rollers are opposite the apex of the picking tappet, and the least forward movement of the loom will start the picking stroke.

Should it be found necessary to afterwards move the large cog wheel by a few teeth in either direction, all that is requisite is to loosen the thumb screws above the crank shaft bearings, and the shaft may then be easily lifted so that the teeth disconnect. Unfortunately in some looms, although the thumb screws are in evidence, their importance has not been sufficiently grasped by the maker, since they do not effect their purpose, and the brake wheel has to be loosened to enable the large cog wheel to be moved in the manner described.

Next follows the setting up of the lathe and its motive parts, the breast beam, draft beam and top frame, the taking-up roller, cloth beam, regulator and ratchet motion, disconnecting gear, brake, warp brake, and finally the change-box mechanism (if used), treadles and dobby—or Jacquard machine.

The explanations already given will make it sufficiently clear how these several parts engage with and interact upon one another.

Important Details in Starting the Power Loom.

The points here mentioned are solely designed for the instruction of those who have had but little, if any, practical experience in tending power looms.

Where the skill resulting from habitual practice has not been acquired, unusual care is required in starting the loom, and the novice will do well to first turn the fly wheel or brake wheel by hand until the cranks on the crank shaft point backwards or upwards—the former for choice. At first the movement of the loom must be followed, pick by pick, to see whether the shuttles enter the boxes properly or rebound. In the latter case remedial measures must be instantly adopted or missed picks are likely to ensue from the jamming of the shuttles when the boxes are changed—in the case of multiple-weft fabrics—or smashes result from the insufficient force of the picking stroke if the shuttle does not lay flush against the picker.

It is particularly necessary to see that the shuttles are not changed into their wrong boxes, and in many cases this is guarded against by numbering them.

Although in looms fitted with automatic protectors it is not easy for a smash to occur, the loom being thrown out of gear if the shuttle fails to reach the box, the risk is more imminent in looms with reed guards, since loose warps may not offer the necessary resistance in time to push the reed back out of the reach of the lathe. Before starting the loom the boxes should be carefully overhauled to see whether the shuttles are flush up against the pickers.

Except in single-shuttle treadle looms, reversing is not advisable, since with change boxes it may lead to the wrong box coming into position, or cause the hooks to miss in the case of dobbies or Jacquards.

The weft bobbin must be pushed tightly on the shuttle

spindle, to prevent displacement under the high rate of speed. If the elasticity of the spindle is not sufficient to hold the bobbin fast, assistance is afforded by driving a small wedge of hard wood up between the spindle and its spring.

The Negative Regulator (*Taking-up Motion*).

This motion differs from positive taking-up motions in that it only comes into action when a pick is inserted ; hence if no pick is made the taking-up roller is not advanced. The arrangement is as follows :—

A pawl mounted on a lever engages in the ratchet wheel, the lever being movable along the frame and drawn forward by means of a projecting stud attached to the lathe. The pawl is thus moved and retains the ratchet wheel in connection with the lever until the lathe has beaten up the weft. As soon as the tension on the cloth is released by the pressure of the lathe, the lever, which is weighted at one end, presses the pawl and the ratchet wheel is moved forward. One or more detents prevent the ratchet wheel from slipping back, and thus enable the forward impulse to be repeated at the next stroke.

It will be easily understood that this taking-up motion is unsuitable for very lightly beaten-up fabrics.

If it should happen that smashes are of frequent occurrence, the lathe should be moved forward to the front dead point, and the fabric examined to see whether a fold is produced in front of the reed. In such event the warp must be more strongly braked, in order that the weft can be beaten up better. Provided no other defects are present in the mechanism, this precaution will at once afford a remedy.

The Reed-beater on the "Jucker" Loom.

On this quick-running loom (178 to 180 turns) the beating-up arrangement is different from all others.

Underneath and behind the reed is a reed bar which can be lifted and lowered and is in connection with the shuttle-box swells, whereby it is lifted, and thus holds the reed fast as soon as the shuttle enters the box.

At the instant the lathe beats up the fabric, a finger attached to the crank, underneath the lathe, acts upon the reed bar and assists the retention of the reed during the heaviest part of the stroke, at the same time relieving the strain on the swells.

The reed bar is prevented from sinking, while the shuttle is passing through the shed, by a couple of iron blocks mounted on the frames. The shaft underneath and parallel to the lathe carries at each side a frog which slides over the corresponding block whilst the lathe is in motion, and as long as the frogs are in this position so long is the reed bar supported, although no shuttle is in the box.

In setting this part the main point to be considered is the horizontal adjustment of the iron blocks, because as soon as the shuttle has arrived at the box the frogs must leave the blocks in order to allow time for the reed bar to drop during the advance of the lathe, provided the shuttle has failed to reach its destination, *i.e.*, has become jammed in the shed.

When the loom is in proper working order, the reed bar should never drop. If the loom is turned when the shuttle is absent from the box, attention must be devoted to seeing that the rail properly engages with the reed after the shuttle has been replaced. With this object the loom is turned forwards until both frogs have dropped away from the blocks, but not much further. The reed rail is now depressed, the reed pressed by the hand behind the lathe cap and on to the

shuttle race, and the loom is reversed until the lathe is right out. At the same time the reed is fastened up again, the shuttle can be returned to its box and the loom safely restarted. It should be noted that the dropping of the frogs should at least coincide with the position of the crank on top centres, or preferably a little sooner. Moreover, that though all the parts work with great accuracy, carelessness may nevertheless yield a bitter harvest of smashes.

The Crank Loom (Crompton System).

Principal Details of Mounting Bed Frame.

In the first place the two walls of the loom are connected with the cross frames or traverses, and the screws are tightened up when it is evident that the parts fit properly together.

The next step is to mount the crank shaft; and it should be noted that, in all the movable parts, the bearings must be previously cleansed from dirt; oiling at the same time is advisable. After screwing on the bearings, the easy running of the crank shaft must be seen to.

Intermediate Gear.

The intermediate shaft is put in position, parallel to the wall of the loom, the loose pulley is slid on the shaft, and the cone fixed in place by screws.

When it is certain that all these parts run easily, the large main driving wheel is keyed on to the crank shaft, care being taken that the teeth of the latter engage properly with the cone wheel on the intermediate shaft, but without pressure.

Lathe.

After the lathe has been inserted and is properly mounted, the bent levers are connected with the crank shaft and lathe.

The lathe pin bearings must not be tightened too much by the key on the sword, neither should too much play be allowed, this being disadvantageous.

In this connection, whilst a practised hand can rely on his own knowledge to have the setting correct, the novice should test the accuracy of the adjustment by turning the cone.

Disconnecting Gear.

The attachment of the breast beam and top frame is then proceeded with, and it will be well to set the disconnecting gear in working order. When the parts are fitted together, care must be taken that the disconnecting crank moves through an arc of not more than 90° in starting and stopping, and further, that when the apparatus is in gear, the double nuts on the extreme outer end of the draft rod, between crank and lever, are $\frac{1}{12}$ of an inch away from the latter, so as to enable the spiral spring on the draft rod to press the loose pulley against the cone.

The said double nuts are placed as far forward as possible, in order to prevent excessive pressure on the spiral spring when the mechanism is in gear; this can be best determined by noting the ease or difficulty with which the rod acts when being moved in or out of gear. The pressure of the spring should, however, be sufficient to prevent slipping of the cone and loose pulley.

The double nuts enclosing the brake lever must not press on the latter. Finally, it must not be forgotten that wherever double nuts are used they must be tightened up together as closely as possible, so as to prevent their working loose under the influence of vibration.

The Picker.

The picker and box mechanism is next set in motion, but it is not considered necessary to go into details on this point,

since continual, if merely slight, modifications or improvements are introduced by all the best loom makers every year.

Adjusting the Shuttle Box.

The alignment of the shuttle box to the race is in many cases a source of no inconsiderable trouble. In most looms the change levers are slotted to facilitate the adjustment of the screw pins fitting therein and serving for the attachment of the box. A straight-edge or rule (preferably of iron) affords the best means of proving the accuracy of the alignment.

Each box motion is fitted with a safety coupling which becomes disconnected automatically whenever any obstacle is opposed to the movement of the box—such, for instance, as a jamming of the picker, shuttle, etc. It will be necessary to see that this coupling is in good working order, but no definite directions can be given on this point, the method of examination depending on the construction of the box motion. Of course, though, the trial must in all cases be made when the loom is at rest.

The Stop- or Throw-off Motion.

Parallel to the lathe block is mounted a percussion roller provided at the centre with a spur, forming one piece with the roller—and carrying at the end a throw-off striker attached by a set screw. At each end the roller is in direct connection with a finger, which is pressed gently against the swells of the shuttle box by a spring. This appliance being of great importance in power looms, it must imperatively be in good working order, and care should be taken with regard to the following points:—

At the middle of the breast beam is a buffer spring provided with a nose, in which the spur engages when the lathe is moved forward. The same applies equally to the throw-

off and the throw-off crank. If such is not the case, it must be remedied by adjusting or bending the finger or throw-off, an easy matter provided it be done with care. The spur, however, must not be bent.

The Dobby.

After the two walls of the dobby frame have been accurately fitted, the shaft for actuating the knife is put in order and the treadles are suspended on their pins. The knives are then inserted through the slot in the framework, and are attached to the connecting rods leading to the knife shaft.

The connecting rods joining the crank shaft to the dobby are next attached, the loom being turned for this purpose, so that the pin on the crank pulley is exactly at top centre. In this position the dobby is considered as closed. The connecting rods are now to be lengthened or shortened so that the knives do not press against the (now vertically situated) treadles, but leave an intervening space of $\frac{1}{12}$ to $\frac{1}{8}$ of an inch.

In setting the cylinder, use is made of a pattern card, which, attached to an endless chain, is applied to the cylinder. At the front end of the cylinder spindle is placed the so-called lantern, which is designed for the turning hooks; and also the star against which the cylinder presser acts under the draft exerted by a strong spring.

In many looms the star and lantern, which are made in one piece instead of being keyed or rigidly attached to the spindle, are fastened by adjusting screws.

To adjust the cylinder—the machine being in the closed position, and the cylinder presser acting on one of the depressions on the star—the roller must be set exactly at right angles to the bottom board, *i.e.*, so that it presses the needles mostly upwards; whereupon the adjusting screws are tightened up with care.

In raising or lowering the cylinder for adjustment, the intervening space between the point of the knife and the needle—where raised needles are in question—must be the same as that between the bottom board and a hole on the pattern card in the case of lowered needles.

At each stroke, the cylinder is advanced one card by the turning hook, and this movement must be effected at precisely the same instant as the knives commence to move apart.

Final Details of Mounting.

After all the remaining parts of the mechanism—such as warp tension, cloth-beam adjustment, etc.—have been put in order, the accurate working of the entire loom must be supervised; the measurement of the length of driving belt required is taken, by laying either the belt itself or a cord over the driving and shafting pulleys. In the former case the belt is made about 4 inches, and in the latter about 8 inches shorter than the measured length, the exact amount depending on the actual length, and on the quality of the material; the width should be from $2\frac{1}{2}$ to 3 inches. The loom is then started without a shuttle, to see that the parts work harmoniously. Later, a shuttle is put in, and when the boxes work accurately several shuttles can be tried at once. Care must however be taken to see that each one works without rebounding or defective throw, these faults, if present, being remedied as in the case of the looms already described.

Pick Counter in Buckskin Looms.

In many weaving establishments the looms are fitted with turn- or pick counters to control the number of picks and earning capacity of the loom. They are attached in such a manner that at each revolution, *i.e.*, pick, the figures on the dial advance a unit.

As a rule, these counters in dobby looms are driven from

the cylinder spindle; and as this in a complete turn usually makes six picks, the figures on the dial are advanced by six units.

There are various patterns of counters in existence, but many of them leave much to be desired in point of accuracy. In consequence of this, the author, considering that the construction of a counting meter ought to be feasible, designed in 1889 a meter on a different plan to those in use.

It consists of six small white circular discs, each mounted so as to rotate on a small pin. At the backs of the discs are small cog wheels, each provided with ten teeth, and, in addition, a small pallet, which at each complete revolution of the toothed wheel and disc, engages with the next wheel and moves it forward one tooth. The discs are stamped with figures from 1 to 0, and are mounted parallel side by side. In turning, one moves towards the right hand and the next one to the left, the first registering the units, the second the 10's, the third 100's, the fourth 1000's, the fifth 10,000's, the sixth 100,000; so that at the end of 100,000 picks the counter is run down. Of course, by increasing the number of discs, the registering capacity can be extended *ad infinitum*.

Small springs are provided to enable the wheels and discs to move and stop instantly.

A dial-plate with a corresponding number of apertures for revealing the exact figures and covering the remainder is placed over the discs. This counter has been found to act admirably. It is put on the market by several firms, and is now supplied in an iron case, instead of a wooden one as formerly.

Divers Calculations.

In calculating the size of pulleys for a given number of revolutions, or the number of turns that will be made by

pulleys of known diameter, the driving pulley is invariably the dividend and the driven one always the divisor. The diameter of the pulley is measured in inches and the minute is selected as the unit of time. In the case of cog wheels, the teeth are counted. These conditions are invariable, whatever the speed calculation refers to, *e.g.*, number of revolutions of the loom, driving pulley, shafting pulley, engine fly wheel or driving pulley, etc.

Calculating Speed of Loom.

To ascertain the number of turns made by a loom with a given diameter of driving pulley and given diameter and speed of shaft pulley, the two latter factors are multiplied together and divided by the first named.

Thus, with a shafting speed of 160 turns and a pulley 12 inches in diameter, the driving (loom) pulley being 16 inches, we have :—

$160 \times 12 = 1920 \div 16 = 120$ turns of the loom.

Calculating (Loom) Driving Pulley.

In this case the speed of the loom and the speed and diameter of the shafting pulley being known, the product of the two latter is divided by the former, *e.g.* :—

Shafting speed, 130 turns; diameter of pulley, 16 inches; speed of loom, 140 turns.

$130 \times 16 = 2080 \div 16 = 14{\cdot}85$ inches diameter of loom pulley.

Calculating Shafting Pulley.

To ascertain the diameter of shafting pulley necessary to drive a loom carrying a pulley of known diameter, at a given speed, the speed of the shafting being also known, the product of the two former factors is divided by the latter. For example :—

Speed of loom, 110 turns; diameter of loom pulley, 14 inches; speed of shafting, 140 turns.

$110 \times 14 = 1540 \div 140 = 11$ inches (diameter of shafting pulley).

Speed of Shafting.

To determine the number of turns to be made by a shafting, the diameter of the driving pulley is multiplied by its own speed (or by that of the engine when the latter is the direct motor) and divided by the pulley that is to be driven. Thus:—

Driving pulley, 136 inches $\times$ 50 turns $= 6800 \div 48$ inches (driven pulley) $= 141{\cdot}7$ (142) turns as the speed of the shafting.

Calculating Pulley for Driving the Shafting.

If it be desired to find out the size of pulley required for a given speed of shafting, the driving pulley is multiplied by its own speed—or if the driving be from the engine, by the speed of the motor itself—and the product divided by the desired shafting speed.

Example:—

Driving pulley 100 inches $\times$ 60 turns
$= 6000 \div 120$ (desired speed)
$= 50$ inches, diameter of driven pulley.

In buckskin crank-looms, the speed ratio is generally 1 : 3, so that for each turn of the loom the pulley makes three revolutions. This has, consequently, to be borne in mind in determining the size of the shafting pulleys, and it is therefore best to multiply the pulley diameter by 3.

Example:—

Speed desired (turns) 60×18 inches (driving pulley)
$= 1080 \div 150$ (turns of the shafting)
$= 7{\cdot}2$ inches $\times 3 = 21{\cdot}6$ inches,
the diameter of the pulley.

Methods of Working Various Change Cards.

It will be of considerable advantage, in view of the various drop-box combinations, to become more closely acquainted with the method of working the change cards. By observing the subjoined tables it will be easy to arrange these cards in any desired combination. The squares ■ represent holes in the cards. In the case of heavy looms (mostly cloth and buckskin looms) ■ indicates a peg and □ a hole; and it should be noted that in all cases the terms "right" and "left" must be considered as applying to the ascending side of the cards.

Hacking Drop-box Change (Right-handed).

Here the cards are intended for two holes:—

A blank on the left raises or lowers 1 box.
,, right ,, 2 boxes.
,, each side ,, 3 ,,
One hole on each side leaves the boxes at rest.

Accordingly the complete set of changes is as follows:—

	L.	R.
From 1 to 2 Box		■
,, 1 ,, 3 ,,	■	
,, 1 ,, 4 ,,		
,, 2 ,, 1 ,,		■
,, 2 ,, 3 ,,		
,, 2 ,, 4 ,,	■	
,, 3 ,, 1 ,,	■	
,, 3 ,, 2 ,,		
,, 3 ,, 4 ,,		■
,, 4 ,, 1 ,,		
,, 4 ,, 2 ,,	■	
,, 4 ,, 3 ,,		■

The Hohlbaum Change (Left-handed).

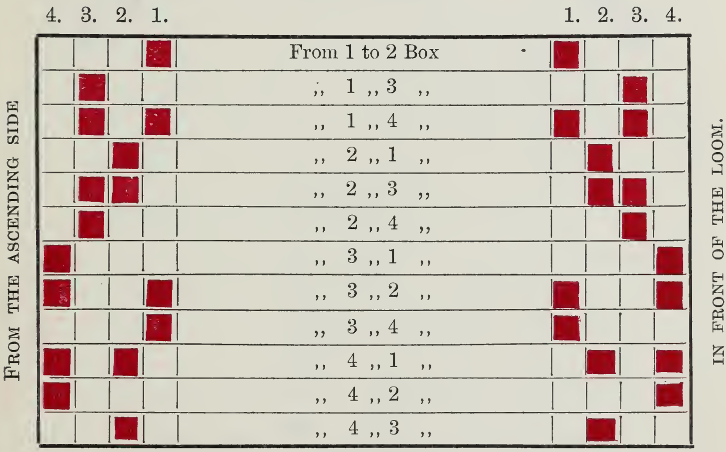
The arrangement corresponds exactly to the Hacking change.

The Honegger Change (Right-handed).

Here the cards are arranged for four holes, and must be understood as from right to left.

Hole No. 1 lifts 1 box.
,, 2 lowers 1 box.
,, 3 lifts 2 boxes.
,, 4 lowers 2 boxes.
,, 1 and 3 lift 3 boxes.
,, 2 and 4 lower 3 boxes.
A blank leaves the boxes at rest.

The complete series is shown below :—



The Hofmann Change (Right-handed).

The cards are arranged for four holes, which must be read from right to left.

Hole No. 1 gives box No. 1.
,, 2 ,, 2.
,, 3 ,, 3.
,, 4 ,, 4.
A blank card gives no change.

The complete set is shown in the following table :—

FROM THE ASCENDING SIDE — IN FRONT OF THE LOOM.

4.	3.	2.	1.		1.	2.	3.	4.
		■		From 1 to 2 Box		■		
	■			,, 1 ,, 3 ,,			■	
■				,, 1 ,, 4 ,,				■
			■	,, 2 ,, 1 ,,	■			
	■			,, 2 ,, 3 ,,			■	
■				,, 2 ,, 4 ,,				■
			■	,, 3 ,, 1 ,,	■			
		■		,, 3 ,, 2 ,,		■		
■				,, 3 ,, 4 ,,				■
			■	,, 4 ,, 1 ,,	■			
		■		,, 4 ,, 2 ,,		■		
	■			,, 4 ,, 3 ,,			■	

In this system the preparation of the cards is very simple, since the box number always corresponds with that of the hole.

The Simple Revolving Box (Right-handed).

The change cards are arranged for two holes.

A hole on the left turns the revolver to the left.
,, right ,, ,, right.
A blank leaves the boxes unchanged.

The Eccentric Revolving Box (Right-hand Driver).

In this case the cards are for five holes, read from left to right.

Hole No. 1 turns the revolver to the left.
,, 2 ,, ,, right.
,, 3 ,, by 2 boxes.
,, 4 ,, by 3 boxes.
,, 5 ,, by 1 box.
A blank leaves the boxes unchanged.

The complete set is shown below :—

	1.	2.	3.	4.	5.
1 Box to left	■				■
2 ,, ,,	■		■		
3 ,, ,,	■			■	
1 ,, right		■			■
2 ,, ,,		■	■		
3 ,, ,,		■		■	

The Hartmann Box Motion (Right-handed).
(Sevenfold Change.)

The change cards are arranged for four pegs or four holes; to be read from left to right.

No. 1 hole lifts, No. 1 peg lowers, 2 boxes to the left.
,, 2 ,, 2 ,, 2 ,, right.
,, 3 ,, 3 ,, 1 box to the left.
,, 4 ,, 4 ,, 1 ,, right.
To leave a box at rest, the last card is repeated in duplicate.

The subjoined table gives the complete set of changes :—

LEFT.	1.	2.	3.	4.	RIGHT.
1 Box	■	■	■	■	1 Box
1 ,,	■	■	■		2 ,,
1 ,,	■		■	■	3 ,,
1 ,,	■		■		4 ,,
2 ,,	■	■		■	1 ,,
2 ,,	■	■			2 ,,
2 ,,	■			■	3 ,,
2 ,,	■				4 ,,
3 ,,		■	■	■	1 ,,
3 ,,		■	■		2 ,,
3 ,,			■	■	3 ,,
3 ,,			■		4 ,,
4 ,,		■		■	1 ,,
4 ,,		■			2 ,,
4 ,,				■	3 ,,
4 ,,					4 ,,

The Schoenherr (Positive) Box Motion (Left-handed).

(Sevenfold Change.)

Here also the cards are for four pegs or four holes, to be read from left to right.

No. 1 peg lifts,	No. 1 hole lowers,		1 box to the left.	
,, 2	,,	2 ,,	2 boxes	,,
,, 3	,,	3 ,,	2 boxes to the right.	
,, 4	,,	4 ,,	1 box	,,

A duplicate of the preceding card is employed to keep any box unchanged.

The entire series of changes is shown below :—

LEFT.	1.	2.	3.	4.	RIGHT.
1 Box					1 Box
1 ,,				■	2 ,,
1 ,,			■		3 ,,
1 ,,			■	■	4 ,,
2 ,,	■				1 ,,
2 ,,	■			■	2 ,,
2 ,,	■		■		3 ,,
2 ,,	■		■	■	4 ,,
3 ,,		■			1 ,,
3 ,,		■		■	2 ,,
3 ,,		■	■		3 ,,
3 ,,		■	■	■	4 ,,
4 ,,	■	■			1 ,,
4 ,,	■	■		■	2 ,,
4 ,,	■	■	■		3 ,,
4 ,,	■	■	■	■	4 ,,

The Schoenherr (Positive) Box Motion (Left-handed).

(Ninefold Change.)

The cards are arranged for the accommodation of six pegs or six holes, and are to be read from left to right.

No. 1 peg lifts, No. 1 hole lowers, 1 box to the left.
,, 2 ,, 2 ,, 2 boxes ,,
,, 3 ,, 3 ,, 1 box ,,
,, 4 ,, 4 ,, 1 ,, to the right.
,, 5 ,, 5 ,, 2 boxes ,,
,, 6 ,, 6 ,, 1 box ,,
A repeat card maintains box in position.

The complete set of changes is as follows :—

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
1 Box							1 Box
1 ,,				■			2 ,,
1 ,,					■		3 ,,
1 ,,				■	■		4 ,,
1 ,,				■	■	■	5 ,,
2 ,,	■						1 ,,
2 ,,	■			■			2 ,,
2 ,,	■				■		3 ,,
2 ,,	■			■	■		4 ,,
2 ,,	■			■	■	■	5 ,,
3 ,,		■					1 ,,
3 ,,		■		■			2 ,,
3 ,,		■			■		3 ,,
3 ,,		■		■	■		4 ,,
3 ,,		■		■	■	■	5 ,,
4 ,,	■	■					1 ,,
4 ,,	■	■		■			2 ,,
4 ,,	■	■			■		3 ,,
4 ,,	■	■		■	■		4 ,,
4 ,,	■	■		■	■	■	5 ,,
5 ,,	■	■	■				1 ,,
5 ,,	■	■	■	■			2 ,,
5 ,,	■	■	■		■		3 ,,
5 ,,	■	■	■	■	■		4 ,,
5 ,,	■	■	■	■	■	■	5 ,,

The Schoenherr (Positive) Box Motion (Left-handed).

(Elevenfold Change.)

Cards arranged for six pegs or holes, read from left to right.

No. 1 peg lifts,	No. 1 hole lowers,	1 box to the left.			
,, 2	,,	2	,,	2 boxes	,,
,, 3	,,	3	,,	2 ,,	,,
,, 4	,,	4	,,	1 box to the right.	
,, 5	,,	5	,,	2 boxes	,,
,, 6	,,	6	,,	2 ,,	,,

A repeat card is used to retain a box in position.

The full details are shown below :—

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
1 Box							1 Box
1 ,,				■			2 ,,
1 ,,					■		3 ,,
1 ,,				■	■		4 ,,
1 ,,					■	■	5 ,,
1 ,,				■	■	■	6 ,,
2 ,,	■						1 ,,
2 ,,	■			■			2 ,,
2 ,,	■				■		3 ,,
2 ,,	■			■	■		4 ,,
2 ,,	■				■	■	5 ,,
2 ,,	■			■	■	■	6 ,,
3 ,,		■					1 ,,
3 ,,		■		■			2 ,,
3 ,,		■			■		3 ,,
3 ,,		■		■	■		4 ,,
3 ,,		■			■	■	5 ,,
3 ,,		■		■	■	■	6 ,,
4 ,,	■	■					1 ,,
4 ,,	■	■		■			2 ,,
4 ,,	■	■			■		3 ,,

Continued on p. 85.

(Continued from p. 84.)

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
4 Box	■	■		■	■		4 Box
4 ,,	■	■			■	■	5 ,,
4 ,,	■	■		■	■	■	6 ,,
5 ,,		■	■				1 ,,
5 ,,		■	■	■			2 ,,
5 ,,		■	■		■		3 ,,
5 ,,		■	■	■	■		4 ,,
5 ,,		■	■		■	■	5 ,,
5 ,,		■	■	■	■	■	6 ,,
6 ,,	■	■	■				1 ,,
6 ,,	■	■	■	■			2 ,,
6 ,,	■	■	■		■		3 ,,
6 ,,	■	■	■	■	■		4 ,,
6 ,,	■	■	■		■	■	5 ,,
6 ,,	■	■	■	■	■	■	6 ,,

The Grossenhain (Positive) Box Motion (Left-handed).

(Sevenfold Change.)

Cards arranged for four pegs or four holes, and read from left to right.

No. 1 hole lifts, No. 1 peg lowers, 1 box to the left.
,, 2 peg ,, 2 hole ,, 2 boxes ,,
,, 3 hole ,, 3 peg ,, 1 box to the right.
,, 4 peg ,, 4 hole ,, 2 boxes ,,
Repeat cards are used to retain the boxes in position.

The complete series is shown below :—

LEFT.	1.	2.	3.	4.	RIGHT.
1 Box	■		■		1 Box
1 ,,	■				2 ,,
1 ,,	■		■	■	3 ,,
1 ,,	■			■	4 ,,
2 ,,			■		1 ,,
2 ,,					2 ,,
2 ,,			■	■	3 ,,
2 ,,				■	4 ,,
3 ,,	■	■	■		1 ,,
3 ,,	■	■			2 ,,
3 ,,	■	■	■	■	3 ,,
3 ,,	■	■		■	4 ,,
4 ,,		■	■		1 ,,
4 ,,		■			2 ,,
4 ,,		■	■	■	3 ,,
4 ,,		■		■	4 ,,

The Grossenhain (Positive) Box Motion (Left-handed).

(Ninefold Change.)

The cards are arranged for six pegs or six holes, and read from left to right.

No. 1 peg lifts,	No. 1 hole lowers,	1 box to the left.	
,, 2 hole	,, 2 peg	,, 2 boxes	,,
,, 3 peg	,, 3 hole	,, 1 box	,,
,, 4 hole	,, 4 peg	,, 1 box to the right.	
,, 5 peg	,, 5 hole	,, 2 boxes	,,
,, 6 hole	,, 6 peg	,, 1 box	,,

To retain boxes in position, repeat cards are used.

The complete series is given below :—

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
1 Box		■			■		1 Box
1 ,,		■			■	■	2 ,,
1 ,,		■					3 ,,
1 ,,		■		■			4 ,,
1 ,,		■		■		■	5 ,,
2 ,,		■	■		■		1 ,,
2 ,,		■	■		■	■	2 ,,
2 ,,		■	■				3 ,,
2 ,,		■	■	■			4 ,,
2 ,,		■	■	■		■	5 ,,
3 ,,					■		1 ,,
3 ,,					■	■	2 ,,
3 ,,							3 ,,
3 ,,				■			4 ,,
3 ,,				■		■	5 ,,
4 ,,	■				■		1 ,,
4 ,,	■				■	■	2 ,,
4 ,,	■						3 ,,
4 ,,	■			■			4 ,,
4 ,,	■			■		■	5 ,,
5 ,,	■		■		■		1 ,,
5 ,,	■		■		■	■	2 ,,
5 ,,	■		■				3 ,,
5 ,,	■		■	■			4 ,,
5 ,,	■		■	■		■	5 ,,

The Grossenhain (Positive) Box Motion (Left-handed).

(Elevenfold Change.)

Cards arranged for six pegs or six holes, and read from left to right.

No.	1 peg lifts,	No.	1 hole lowers,		1 box to the left.
,,	2 hole	,,	2 peg	,,	3 boxes	,,
,,	3 peg	,,	3 hole	,,	1 box	,,
,,	4 peg	,,	4 hole	,,	1 box to the right.	
,,	5 hole	,,	5 peg	,,	3 boxes	,,
,,	6 peg	,,	6 hole	,,	1 box	,,

Repeat cards are used to retain boxes in position.

Complete series of changes :—

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
1 Box		■			■		1 Box
1 ,,		■		■	■		2 ,,
1 ,,		■		■	■	■	3 ,,
1 ,,		■					4 ,,
1 ,,		■		■			5 ,,
1 ,,		■		■		■	6 ,,
2 ,,	■	■			■		1 ,,
2 ,,	■	■		■	■		2 ,,
2 ,,	■	■		■	■	■	3 ,,
2 ,,	■	■					4 ,,
2 ,,	■	■		■			5 ,,
2 ,,	■	■		■		■	6 ,,
3 ,,	■	■	■		■		1 ,,
3 ,,	■	■	■	■	■		2 ,,
3 ,,	■	■	■	■	■	■	3 ,,
3 ,,	■	■	■				4 ,,
3 ,,	■	■	■	■			5 ,,
3 ,,	■	■	■	■		■	6 ,,
4 ,,					■		1 ,,
4 ,,				■	■		2 ,,
4 ,,				■	■	■	3 ,,

(Continued on p. 89.)

(Continued from p. 88.)

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
4 Box.							4 Box.
4 ,,				■			5 ,,
4 ,,				■		■	6 ,,
5 ,,	■				■		1 ,,
5 ,,	■			■	■		2 ,,
5 ,,	■			■	■	■	3 ,,
5 ,,	■						4 ,,
5 ,,	■			■			5 ,,
5 ,,	■			■		■	6 ,,
6 ,,	■		■		■		1 ,,
6 ,,	■		■	■	■		2 ,,
6 ,,	■		■	■	■	■	3 ,,
6 ,,	■		■				4 ,,
6 ,,	■		■	■			5 ,,
6 ,,	■		■	■		■	6 ,,

The Gülcher (Positive) Box Motion (Left-handed).

(Sevenfold Change.)

Cards arranged for four pegs or four holes, and read from left to right.

No. 1 peg lifts, No. 1 hole lowers, 1 box to the right.
,, 2 ,, 2 ,, 2 boxes ,,
,, 3 ,, 3 ,, 1 box to the left.
,, 4 ,, 4 ,, 2 boxes ,,
Repeat cards are used to keep boxes at a standstill.

Complete set of changes :—

LEFT.	1.	2.	3.	4.	RIGHT.
1 Box					1 Box
1 ,,	■				2 ,,
1 ,,		■			3 ,,
1 ,,	■	■			4 ,,
2 ,,			■		1 ,,
2 ,,	■		■		2 ,,
2 ,,		■	■		3 ,,
2 ,,	■	■	■		4 ,,
3 ,,				■	1 ,,
3 ,,	■			■	2 ,,
3 ,,		■		■	3 ,,
3 ,,	■	■		■	4 ,,
4 ,,			■	■	1 ,,
4 ,,	■		■	■	2 ,,
4 ,,		■	■	■	3 ,,
4 ,,	■	■	■	■	4 ,,

The Gülcher (Positive) Box Motion (Left-handed).

(Ninefold Change.)

Cards arranged for six pegs or six holes, and read from left to right.

No. 1 hole lifts,	No. 1 peg lowers,	1 box to the right.		
,, 2 peg	,,	2 hole ,,	2 boxes	,,
,, 3 peg	,,	3 hole ,,	2 ,,	,,
,, 4 hole	,,	4 peg ,,	1 box to the left.	
,, 5 peg	,,	5 hole ,,	2 boxes	,,
,, 6 peg	,,	6 hole ,,	2 ,,	,,

Repeat cards are used to keep boxes at a standstill.

Complete set of changes :—

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
1 Box	■			■			1 Box
1 ,,				■			2 ,,
1 ,,	■		■	■			3 ,,
1 ,,			■	■			4 ,,
1 ,,		■	■	■			5 ,,
2 ,,	■						1 ,,
2 ,,							2 ,,
2 ,,	■		■				3 ,,
2 ,,			■				4 ,,
2 ,,		■	■				5 ,,
3 ,,	■			■		■	1 ,,
3 ,,				■		■	2 ,,
3 ,,	■		■	■		■	3 ,,
3 ,,			■	■		■	4 ,,
3 ,,		■	■	■		■	5 ,,
4 ,,	■					■	1 ,,
4 ,,						■	2 ,,
4 ,,	■		■			■	3 ,,
4 ,,			■			■	4 ,,
4 ,,		■	■			■	5 ,,
5 ,,	■				■	■	1 ,,
5 ,,					■	■	2 ,,
5 ,,	■		■		■	■	3 ,,
5 ,,			■		■	■	4 ,,
5 ,,		■	■		■	■	5 ,,

The Gülcher (Positive) Box Motion (Left-handed).

(Elevenfold Change.)

Cards arranged for six pegs or six holes, and read from left to right.

No. 1 hole lifts, No. 1 peg lowers, 1 box to the right.
,, 2 peg ,, 2 hole ,, 1 ,,
,, 3 peg ,, 3 hole ,, 3 boxes ,,
,, 4 hole ,, 4 peg ,, 1 box to the left.
,, 5 peg ,, 5 hole ,, 1 ,,
,, 6 peg ,, 6 hole ,, 3 boxes ,,
Repeat cards are used to keep boxes at a standstill.

Complete set of changes :—

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
1 Box	■			■			1 Box
1 ,,				■			2 ,,
1 ,,		■		■			3 ,,
1 ,,	■		■	■			4 ,,
1 ,,			■	■			5 ,,
1 ,,		■	■	■			6 ,,
2 ,,	■						1 ,,
2 ,,							2 ,,
2 ,,		■					3 ,,
2 ,,	■		■				4 ,,
2 ,,			■				5 ,,
2 ,,		■	■				6 ,,
3 ,,	■				■		1 ,,
3 ,,					■		2 ,,
3 ,,		■			■		3 ,,
3 ,,	■		■		■		4 ,,
3 ,,			■		■		5 ,,
3 ,,		■	■		■		6 ,,
4 ,,	■			■		■	1 ,,
4 ,,				■		■	2 ,,
4 ,,		■		■		■	3 ,,

(Continued on p. 93.)

(Continued from p. 92.)

LEFT.	1.	2.	3.	4.	5.	6.	RIGHT.
4 Box	■		■	■		■	4 Box
4 ,,			■	■		■	5 ,,
4 ,,		■	■	■		■	6 ,,
5 ,,	■					■	1 ,,
5 ,,						■	2 ,,
5 ,,		■				■	3 ,,
5 ,,	■		■			■	4 ,,
5 ,,			■			■	5 ,,
5 ,,		■	■			■	6 ,,
6 ,,	■				■	■	1 ,,
6 ,,					■	■	2 ,,
6 ,,		■			■	■	3 ,,
6 ,,	■		■		■	■	4 ,,
6 ,,			■		■	■	5 ,,
6 ,,		■	■		■	■	6 ,,

The Otto Müller Change Motion (Left-handed).

(Sevenfold Change.)

Cards arranged for four pegs or four holes, and read from left to right.

No. 1 hole lifts, No. 1 peg lowers, 2 boxes to the left.
,, 2 ,, ,, 2 ,, ,, 1 box ,,
,, 3 peg ,, 3 hole ,, 2 boxes to the right.
,, 4 ,, ,, 3 ,, ,, 1 box ,,
Repeat cards are used to keep boxes at a standstill.

Complete set of changes :—

LEFT.	1.	2.	3.	4.	RIGHT.
1 Box	■	■			1 Box
1 ,,	■	■		■	2 ,,
1 ,,	■	■	■		3 ,,
1 ,,	■	■	■	■	4 ,,
2 ,,	■				1 ,,
2 ,,	■			■	2 ,,
2 ,,	■		■		3 ,,
2 ,,	■		■	■	4 ,,
3 ,,		■			1 ,,
3 ,,		■		■	2 ,,
3 ,,		■	■		3 ,,
3 ,,		■	■	■	4 ,,
4 ,,					1 ,,
4 ,,				■	2 ,,
4 ,,			■		3 ,,
4 ,,			■	■	4 ,,

SECTION III.

Introduction.

In view of the necessity for abundant technical knowledge exacted by the comprehensive industry of weaving, it is of considerable advantage to have the most important explanatory matters in a handbook arranged together. This requirement is particularly emphatic in cases where the business is not of large extent, and the functions of manager, overlooker, designer, and even manipulator, are combined in the one individual.

A thorough acquaintance with matters relating to yarns is of everyday importance in this business; consequently, a summary is given in the following pages of the various yarns and methods of numbering them met with in commerce. This will afford the reader an opportunity of assimilating the points worth knowing in this connection.

General Remarks on the Numbering, Reeling and Packing of Yarn.

In all classes of yarns that are formed into a thread by spinning, the "number" is equal to the number of units of length contained in a given weight of the product.

The length of yarn required to produce the definite weight on which the numbering is based is called a "hank" (Strähn, Zahle, Schneller, Stück, or Strang), or in the case of flax or jute yarn, a "lay" or "lea" (Gebind). For

example, if a hank of 840 yards (= 768 metres) weighs 1 lb. (453·5 grams), the yarn is a No. 1 yarn; on the other hand, if 10 hanks of 840 yards apiece (8400 yards, or 7680 metres) weigh 1 lb., the yarn is No. 10.

In doubled yarn (twist) only one-half as many hanks—and in three-ply twist only one-third as many—are contained in the weight as the yarn number would imply; *e.g.*, No. 40 doubled yarn contains 20 hanks, No. 40 three-ply only 13½ hanks.

Various systems of numbering yarn are in current use, based on different lengths and weights. In all of them, however, the fundamental rule, the finer the yarn the higher the number, prevails.

Yarn is packed for transit in "bundles" (Bündeln), except in the linen branch, where they are known as "packs" (Schock); and whereas in all other yarns the weight of the bundle remains constant though the length of the constituent yarn varies with the No., the length of a pack of linen yarn is invariable, whilst the weight alters according to the thickness of the yarn, and is lighter as the yarn No. ascends.

As a rule, in the medium Nos. of bundled yarns, the number of skeins per bundle corresponds to the yarn No. In very fine, or extra coarse yarns, this rule does not apply; and, moreover, there is no uniformity as to the No. of yarn at which this deviation begins.

Doubled yarns contain only half as many hanks per skein as the corresponding single yarns; and there are also cases where the number of half hanks in the skein is double the usual quantity.

The majority of the current systems of numbering yarn are given in detail in the following pages:—

1. *Cotton Yarns* (*English System*).

(*a*) *Ordinary Yarns.*

The yarn No. is identical with the number of hanks going to the lb.

1 single bundle = ½ as many skeins as the yarn No. = 5 lb. (2·267 kilos).
1 double ,, = as many ,, ,, = 10 ,, (4·535 ,,).

1 skein	= 10 hanks	= 70 leas	= 5600 turns	= 8400 yds.	= 7680 metres.
	1 hank	= 7 ,,	= 560 ,,	= 840 ,,	= 768 ,,
		1 lea	= 80 ,,	= 120 ,,	= 110 ,,
			1 turn	= 1½ ,,	= 1·37 ,,

(*b*) *Lustred Yarn* (*Eisengarn*).

The yarn No. = 2·8 times the number of hanks going to the lb.

1 bundle = 2·8 as many skeins as the yarn No. = 10 lb.

1 skein	= 28 hanks	= 56 leas	= 5600 turns	= 8400 yds.	= 7680 metres.
	1 hank	= 2 ,,	= 200 ,,	= 300 ,,	= 274 ,,
		1 lea	= 100 ,,	= 150 ,,	= 137 ,,
			1 turn	= 1½ ,,	= 1·37 ,,

(*c*) *Glazed Threads* (*Glanzgarn*).

The yarn No. = twice the number of hanks going to the lb.

1 bundle = twice as many skeins as the yarn No. = 10 lb.

1 skein	= 20 hanks	= 40 leas	= 5600 turns	= 8400 yds.	= 7680 metres.
	1 hank	= 2 ,,	= 280 ,,	= 420 ,,	= 384 ,,
		1 lea	= 140 ,,	= 140 ,,	= 192 ,,
			1 turn	= 1½ ,,	= 1·37 ,,

2. *Flax Yarns* (*Linen Yarn, Tow Yarn*).

(*a*) *English System.*

England.

Yarn No. = number of leas going to the lb.

pack.	b'dles.	hasps.	hanks.	leas.	threads.	yds.	metres.
1	= 10	= 50	= 200	= 2400	= 288000	= 720000	= 658362
	1	= 5	= 20	= 240	= 28800	= 72000	= 65836
		1	= 4	= 48	= 5760	= 14400	= 13167
			1	= 12	= 1440	= 3600	= 3293
				1	= 120	= 300	= 274
					1	= 2½	= 2·285

Ireland.

Yarn No. = number of leas going to the lb.

pack.	b'dles.	hasps.	hanks.	leas.	threads.	yds.	metres.
1	12	60	240	2400	288000	720000	658362
	1	5	20	200	24000	60000	54863
		1	4	40	4800	12000	10973
			1	10	1200	3000	2743
				1	120	300	274
					1	$2\frac{1}{2}$	2·285

(b) *Austrian System.*

Yarn No. = number of hanks per 10 lb. (4·535 kilos).

pack (Schock).	b'dles (Bündel).	hasps (Stück).	hanks (Strähn).	leas (Gebinde).	threads (Faden).	Vienna ells (of 30·6774 ins).	yds.	metres.
1	12	60	240	7200	288000	864000	744288	671810
	1	5	20	600	24000	720000	62024	55984
		1	4	120	4800	14400	12405	11197
			1	30	1200	3600	3101	2799
				1	40	120	$103\frac{1}{2}$	$93\frac{1}{3}$
					1	3	$2\frac{1}{2}$	2·33

3. *Hemp Yarn.*

(Same as Flax Yarn.)

4. *Jute Yarn.*

English System.

(*a*) The yarn No. = the number of leas to the lb.

b'dle.	reels.	hanks.	leas.	threads.	yards.	metres.	
1	2	40	200	24000	60000	54862	
	1	20	100	12000	30000	27431	
		1	5	600	1500	1372	Nos. $1\frac{1}{2}$–12.
			1	120	300	274	
				1	$2\frac{1}{2}$	2·285	

(*b*) The yarn No. = twice the number of leas going to a lb.

b'dle.	reels.	hanks.	leas.	threads.	yards.	metres.	
1 =	4 =	80 =	400 =	24000 =	60000 =	54862	Nos. 1–1½.
	1 =	20 =	100 =	6000 =	15000 =	13715	
		1 =	5 =	300 =	750 =	686	
			1 =	60 =	150 =	137	
				1 =	2½ =	2·285	

(*c*) Yarn No. = four times the number of leas going to a lb.

b'dle.	reels.	hanks.	leas.	threads.	yards.	metres.	
1 =	8 =	160 =	800 =	24000 =	60000 =	54862	Nos. ½–¾.
	1 =	20 =	100 =	3000 =	7500 =	6858	
		1 =	5 =	150 =	375 =	343	
			1 =	30 =	75 =	68·5	
				1 =	2½ =	2·285	

(*d*) Yarn No. = eight times the number of leas going to a lb.

b'dle.	reels.	hanks.	leas.	threads.	yards.	metres.	
1 =	16 =	320 =	1600 =	24000 =	60000 =	54862	No. ¼.
	1 =	20 =	100 =	1500 =	3750 =	3429	
		1 =	5 =	75 =	187·5 =	171·5	
			1 =	15 =	37·5 =	34·25	
				1 =	2½ =	2·285	

5. *China Grass or Ramie Yarns.*

International Metric System.

(Same as for Soft Combed Yarns.)

6. *Hard Combed Yarns (Weft, Mohair, Alpaca, Cheviot).*

English System.

Yarn No. = number of hanks to a lb.

1 bundle = (Yarn No. × 2) skeins = 10 lb.

skein.	hanks.	leas.	turns.	yards.	metres.	
1 =	5 =	35 =	2800 =	2800 =	2560	(*a*) Short Reel, 1 yd. turns.
	1 =	7 =	560 =	560 =	512	
		1 =	80 =	80 =	73	
			1 =	1 =	0·914	

1 bundle = (Yarn No. × 2) skeins = 10 lb.

skein.		hanks.		leas.		turns.		yards.		metres.	
1	=	5	=	35	=	$1866\frac{2}{3}$	=	2800	=	2560	(*b*) Medium Reel, $1\frac{1}{2}$ yd. turns.
		1	=	7	=	$373\frac{1}{3}$	=	560	=	512	
				1	=	$53\frac{1}{3}$	=	80	=	73	
						1	=	$1\frac{1}{2}$	=	1·37	

1 bundle = (Yarn No. × 2) skeins = 10 lb.

skein.		hanks.		leas.		turns.		yards.		metres.	
1	=	5	=	35	=	1400	=	2800	=	2560	(*c*) Long Reel, 2 yd. turns.
		1	=	7	=	280	=	560	=	512	
				1	=	40	=	80	=	73	
						1	=	2	=	1·828	

7. *Soft Combed Yarns.*

International Metric System.

Yarn No. = the number of hanks going to 1 kilo. (2·2 lb).

1 bundle = as many skeins as are expressed by the yarn No. = 5 kilos. (11 lb.)

1 skein	=	5 hanks	=	50 leas	=	3650 turns	=	5000 metres		=	5465 yards.
		1 ,,	=	10 ,,	=	730 ,,	=	1000 ,,		=	1093 ,,
				1 ,,	=	73 ,,	=	100 ,,		=	$109\frac{1}{3}$,,
						1 ,,	=	1·37 ,,		=	$1\frac{1}{2}$,,

8. *Carded Woollen Yarn.*

(*a*) *International Metric System.*

(Same as Soft Combed Yarns.)

(*b*) *Old Austrian System.*

Yarn No. = number of hasps to the Viennese lb. = 560 grams = 1·23 lb.

1 bundle = (Yarn No. × 10) hasps = 10 Viennese lb. = 5·6 kilos. = 12·32 lb.

hasp.		hanks.		leas.		turns.		Vienna ells.		metres.		yards.
1	=	4	=	20	=	880	=	1760	=	1369	=	1496·3
		1	=	5	=	220	=	440	=	342	=	374
				1	=	44	=	88	=	$68\frac{1}{2}$	=	74·8
						1	=	2	=	1·56	=	1·7

(c) German (so-called "Prussian") System, also used in Austria.

Yarn No. = number of hasps going to the Customs lb. (Zoll Pfund) = 500 grams = 1·1 lb.

1 bundle = (Yarn No. × 10) hasps = 10 Zollpfd. = 5 kilos. = 11 lb.

hasp.		hanks (Zahl).		leas.		turns.		Berlin ells.		metres.		yards.
1	=	4	=	20	=	880	=	2200	=	1467	=	1603½
		1	=	5	=	220	=	550	=	367	=	401
				1	=	44	=	110	=	73½	=	80·2
						1	=	2½	=	1·67	=	1·82

Example.—When 550 Berlin ells (*i.e.*, 367 m. or 401 yds.) go to the Zoll Pfd. the yarn is No. ¼.

When 1100 Berlin ells (*i.e.*, 734 m. or 802 yds.) go to the Zoll Pfd. the yarn is No. ½.

When 2200 Berlin ells (*i.e.*, 1468 m. or 1603½ yds.) go to the Zoll Pfd. the yarn is No. 1.

(d) Old Saxon Method of Making-up.

Yarn No. = number of hanks going to 1 Berlin trade lb. (Berliner Handelspfund) = 467·7 grams = 1·03 lb., or to 1 Zoll Pfund = 500 grams = 1·1 lb.

1 bundle = (Yarn No. × 10) skeins per 10 Handelspfund (10·3 lb.) or 10 Zoll Pfund (11 lb.)

skein.		hanks.		leas.		turns.		Leipzig ells.		metres.		yards.
1	=	10	=	50	=	4000	=	8000	=	4520	=	4940
		1	=	5	=	400	=	800	=	452	=	494
				1	=	80	=	160	=	90½	=	98·8
						1	=	2	=	1·13	=	1·23

(e) Also as in Vicuna Yarn.

N.B.—Carded Yarn is always understood as being in the "grease," and will give a loss of from 13 to 15 °/ₒ of fat.

9. *Vicuna Yarn.*

Old Saxon Method of Making-up, but Adjusted to English Measure by Commercial Usage.

Yarn No. = number of hanks going to the Berlin "Han-

delspfund" = 467·7 grams (1·03 lb.); or to the "Zoll Pfund" = 500 grams (1·1 lb.)

1 bundle = (Yarn No. × 10) skeins = 10 Handelspfund (10·3 lb.) or = 10 "Zoll Pfund" (11 lb.)

skein.		hanks.		leas.		turns.		yards.		Leipzig ells.		metres.
1	=	10	=	40	=	3200	=	4800	=	7800	=	4400
		1	=	4	=	320	=	480	=	780	=	440
				1	=	80	=	120	=	195	=	110
						1	=	$1\frac{1}{2}$	=	2·4375	=	1·37

10. *Chappe Silk Yarn* (*Floret Silk, Spun Silk, Bourette*).

International Metric System.

(Same as Combed Yarn.)

11. *Shoddy Yarn.*

(*a*) *Old Brünn System.*

Yarn No. = number of hanks going to the Viennese lb. (= 560 grams or 1·23 lb.).

1 pack = (Yarn No. × 10) hanks = 10 Viennese lb. = 5·6 kilos. = 12·3 lb.

hank.		leas.		turns.		Viennese ells.		metres.		yards.
1	=	4	=	880	=	1760	=	1369	=	$1496\frac{1}{4}$
$\frac{1}{4}$	=	1	=	220	=	440	=	342	=	374
				1	=	2	=	1·55	=	1·7

(*b*) *New Metric System.*

Yarn No. = number of hanks per kilo. (2·2 lb.).

1 pack = (Yarn No. × 5) hanks = 5 kilos. (11 lb.)

1 hank	=	2 leas	=	670 turns	=	1000·5 metres	=	$1093\frac{1}{2}$ yards.
$\frac{1}{2}$,,	=	1 ,,	=	335 ,,	=	502·5 ,,	=	$546\frac{1}{2}$,,
				1 ,,	=	1·5 ,,	=	$1\frac{5}{8}$,,

(*c*) *Old Viennese System* (*seldom used*).

Yarn No. = number of hanks going to the Viennese lb. (Pfund) = 560 grams = 1·23 lb.

1 pack = (Yarn No. × 10) hasps = 10 Viennese lb. = 5·6 kilos. = 12·3 lb.

hasp.		hanks.		leas.		turns.		Viennese ells.		metres.		yards.
1	=	4	=	16	=	800	=	1600	=	1240	=	$1355\frac{1}{2}$
		1	=	4	=	200	=	400	=	310	=	339
				1	=	50	=	100	=	$77\frac{3}{4}$	=	$84\frac{3}{4}$
						1	=	2	=	1·55	=	$1\frac{3}{4}$

Example of the Brünn System.

If 440 Viennese ells (= 220 turns) weigh 1 Viennese lb., the yarn is No. $\frac{1}{4}$; if 880 Viennese ells (= 440 turns) go to the Viennese lb., the yarn No. is $\frac{1}{2}$.

With 1320	Viennese ells	(= 660 turns)	the No. =	$\frac{3}{4}$.
,, 1540	,,	(= 770 ,,)	,,	$\frac{7}{8}$.
,, 1760	,,	(= 880 ,,)	,,	1, and so on.

Example of Metrical System for Shoddy Yarn.

If 100 metres (= 67 turns) of the yarn go to 1 kilo., the yarn is No. $\frac{1}{10}$; if 200 metres (=134 turns), No. $\frac{2}{10}$; 500 metres (= 335 turns), No. $\frac{1}{2}$; 1000 metres (= 670 turns), No. 1, and so on.

Example of Viennese System.

If 100 Viennese ells (= 50 turns) go to the Viennese lb., the yarn is No. $\frac{1}{16}$; if 200 Viennese ells (= 100 turns), then the yarn is No. $\frac{2}{16}$; and if 1600 Viennese ells (=800 turns), No. 1.

It should be mentioned that shoddy yarns are seldom made finer than No. 5.

Shortage of Yarns.

In the preceding list of yarns only the systems of numbering chiefly in use are considered. There are others occasionally employed, but the multiplicity of systems is more an accidental circumstance than an actual practical necessity.

Thus, for example, the old Saxon hank had a length of 800 Leipzig ells (= 452 metres, or 494 yards), made up of 4 lays of 80 5-foot turns; through commercial custom, however, it became assimilated to the English system of $1\frac{1}{2}$ yard reels, so that the hank of Vicuna now measures 440 metres (480 yards).

Nearly all yarns undergo a loss of length, whether through tight packing, washing, bleaching or dyeing, so there is

Table showing the various lengths and weights of yarn in hanks, reeled according to the several systems of numbering.

Standard of Measurement.	Presumptive Length.	Standard of Weight.	Length.		Weight.		Actual Length.	Calculated Length.
			m.	yds.	grams.	lb.		
Hank. Cotton (English).........	840 yds.	1 lb.	768	840	453½	1		
,, ,, (French).........	1000 m.	½ kilo.	1000	1093	500	1·1		
,, ,, (German)........	1151 Berlin ells	1 Berl. Handelspfd.	768	840	467·7	1·03		
,, ,, (Austrian).......	1488 Vien. ells	1 Austrian Pfund	1159	1266¾	560	1·23		
,, ,, (Intl. Metr.).....	1000 m.	1 kilo.	1000	1093	1000	2·2		
,, Carded Yarn (Saxon)...	800 Leipzig ells	1 Berl. Handelspfd.	452	494	467·7	1·03		
,, ,, (,,)...	800 ,,	1 Zoll Pfund	452	494	500	1·1		
,, ,, (Austrian)	565 Vien. ells	1 Vien. Pfund	440	481	560	1·23		
,, ,, (,,)	1760 ,,	1 ,,	1369	1496·3	560	1·23		
Hasp. ,, (Prussian)	2200 Berlin ells	1 Zoll Pfund	1467	1603½	500	1·1		
,, ,, (Berlin)...	2200 ,,	1 Berl. Handelspfd.	1467	1603½	467·7	1·03		
,, ,, (German)	2059 ,,	1 ,, ,,	1373	1500½	467·7	1·03		
Hank. Carded Yarn (Cockerill, Belgian)................	2240 ,,	1 Zoll Pfund	1497	1636	500	1·1		
Hank. Carded Yarn (Sedan. Fr.)	1256 aunes (ells)	½ kilo.	1493	1632	500	1·1		
,, ,, (,,)	1256 ,, (,,)	1 Paris lb.	1493	1632	489	1·08		
,, ,, (Elbeuf. Fr.)	3600 m.	½ kilo.	3600	3935	500	1·1		
,, ,, (English).....	560 yds.	1 lb.	512	560	453½	1		
,, ,, (Intl. Metr.)	1000 m.	1 kilo.	1000	1093	1000	2·2		
,, Combed Yarn (French)	600 aunes	½ ,,	720	787	500	1·1		
,, ,, (English)	560 yds.	1 lb.	512	560	453½	1		
,, ,, (Intl. Metr.)	1000 m.	1 kilo.	1000	1093	1000	2·2		

Hank. Combed Yarn, Weft, Mohair, Alpaca, Cheviot (English)........................	560 yds.	1 lb.	512	560	453½	1		
Hank. Linen Yarn, Tow Yarn, Hemp Yarn (Austrian).......	3600 Vien. ells	10 ,,	2799	3101	453½	1		
Lay. Linen Yarn, Tow Yarn, Hemp Yarn (German).......	300 yds.	1 ,,	274	300	453½	1		
Lay. Linen Yarn, Tow Yarn, Hemp Yarn (English)........	300 ,,	1 ,,	274	300	453½	1		
Lay. Linen Yarn, Tow Yarn, Hemp Yarn (French)........	300 ,,	1 ,,	274	300	453½	1		
Lay. Jute Yarn (English)......	300 ,,	1 ,,	274	300	453½	1		
Hank. Vicuna Yarn, Carded Yarn (Saxon)..................	780 Leipzig ells	1 Zoll Pfund	440	481	500	1·1		
Hank. Vicuna Yarn, Carded Yarn (Intl. Metr.)............	1000 m.	1 kilo.	1000	1093	1000	2·2		
Hank. Chappe Silk (Intl. Metr.)	1000 m.	1 ,,	1000	1093	1000	2·2		
,, ,, (English)...	840 yds.	1 lb.	768	840	453½	1		
,, ,, (Swiss and Fr.)	500 m.	½ kilo.	500	547	500	1·1		
,, Lustred Yarn (English)	2·8 × 300 yds.	1 lb.	768	840	453½	1		
,, Glazed Yarn (,,)	2 × 420 yds.	1 ,,	768	840	453½	1		
,, Ramie (Intl. Metr.)......	1000 m.	1 kilo.	1000	1093	1000	2·2		
,, ,, (English)..........	300 yds.	1 lb.	274	300	453½	1		
,, Shoddy Yarn (Austrian, Brünn).........................	1760 Vien. ells	1 Vien. Pfund	1369	1496·3	560	1·23		
Hank. Shoddy Yarn (Intl. Mtr.)	1000 m.	1 kilo.	1000	1093	1000	2·2		
,, ,, (Viennese)	1600 Vien. ells	1 Vien. Pfund	1240	1355·3	560	1·23		
Hasp. ,, (German)	2000 Berlin ells	1 Zoll Pfund	1334	1458	500	1·1		
,, ,, (,,)	1940 ,,	1 ,,	1294	1414·3	500	1·1		

almost always a shortage in each hank. Although, by reason of the variety of qualities and grades of yarn met with in commerce, it is impossible to fix any definite limit for this shortage, the author's experience shows that :—

	Nominal.			Actual.	
	metres.	yards.		metres.	average yards.
English Cotton Yarn =	768	(= 840)	=	738–748	(= 810)
Metric Combed Yarn =	1000	(= 1093)	=	960–970	(= 995)
Saxon Carded Yarn =	452	(= 494)	=	420–430	(= 465)

It is therefore advisable, before beginning to calculate, to ascertain the exact length of the hanks by winding two or three on an accurate reel. This being done, and the average actual length determined thereby, about 2 to 5 °/₀ should be deducted for spooling and the like, the remainder giving the net length for calculation.

Accordingly, the total shortage of a hank amounts to between 5 and 10 °/₀, and the subjoined list gives the usual net lengths of ordinary yarn :—

Yarn.		metres.		yards.		metres.		yards.
English Cotton, single	=	720	=	787	instead of	768	=	840
,, ,, doubled	=	700	=	765	,,	768	=	840
,, ,, 3-ply	=	680	=	743	,,	768	=	840
,, Woollen, single	=	500	=	546½	,,	512	=	560
,, ,, doubled	=	480	=	524½	,,	512	=	560
Metric Combed Yarn, single	=	960	=	1049	,,	1000	=	1093
,, ,, doubled	=	940	=	1027	,,	1000	=	1093
,, Carded Yarn, single	=	960	=	1049	,,	1000	=	1093
,, ,, doubled	=	940	=	1027	,,	1000	=	1093
Austrian Linen Yarn, single	=	2600	=	2935	,,	2799	=	3101
,, ,, doubled	=	2550	=	2787	,,	2799	=	3101
Metric Chappe Silk, ,,	=	940	=	1027½	,,	1000	=	1093

etc., etc.

The preceding table (p. 104) has been compiled to show the relative bases of the various systems—especially for carded yarns—at a glance. The two vacant columns at the right-hand side are left for noting down the actual and calculated lengths found in practice.

Comparison of Yarn-numbering Systems.

From the foregoing variations in the length of hanks and the relative weights of same, it is evident that it cannot be a matter of indifference whether a given yarn No. is chosen from any system indiscriminately; since, for example, an 840 yard length of yarn, weighing 1 lb., will be No. 1 in the English system for cotton, No. 1½ weft, and No. 1·693 in the metric system.

To convert one system into another and find their relative values, the following points must be observed :—

1. Multiply the number of units of length in a hank of the (*e.g.*, No. 1) yarn of a given system with the number of weight units of the desired system.

2. Multiply the number of length units of a hank of yarn in the desired system by the number of weight units of the given system.

3. Divide the product 1 by the product 2, and the result will give the corresponding yarn No. in the desired system.

Example.

What German No. of shoddy yarn (No. 1 = 1294 metres per 500 grams) is equivalent to Austrian shoddy yarn No. 1 (= 1369 metres per 560 grams)?

Austrian No. 1	= 1369 metres per		560 grams.	
German ,,	= 1294	,,	500	,,

1. 2.

1369 metres × 500 grams = 684500. 1294 metres × 560 grams = 724640

684500 ÷ 724640 = 0·945; *i.e.*, Austrian No. 1 corresponds to the German No. 0·945.

By reversing the operation and dividing product 2 by product 1 we obtain the Austrian No. corresponding to German No. 1 yarn; *e.g.* :—

724640 ÷ 684500 = 1·059 : *i.e.*, German shoddy yarn No. 1 is equivalent to Austrian No. 1·059.

Cotton Yarns.	Also Lustre Yarn, Chappe Silk.	English, 840 yards per 1 lb.	1	1·181	1·032	1·222	0·571	0·534
		French, 1000 metres per ½ kilo.	0·847	1	0·821	1·035	0·483	0·452
		German, 1151 Berlin ells per 1 Berlin Handelspfund.	0·969	1·218	1	1·26	0·589	0·55
		Austrian, 1488 Viennese ells per 1 Viennese lb.	0·818	0·966	0·793	1	0·467	0·437
Carded Yarns.		Saxon, 800 Leipzig ells per 1 Berlin Handelspfund.	1·752	2·069	1·699	2·141	1	0·935
		Saxon, 800 Leipzig ells per 1 Zollpfund.	1·873	2·212	1·816	2·289	1·069	1
		Austrian, 565 Viennese ells per 1 Viennese lb.	1·853	2·187	1·796	2·564	1·197	1·12
	Also Shoddy Yarns.	Austrian, 1760 Viennese ells per 1 Viennese lb.	0·692	0·819	0·672	0·847	0·395	0·37
		Prussian, 2059 Berlin ells per 1 Berlin Handelspfund, or 2200 Berlin ells per 1 Zollpfund.	0·577	0·682	0·56	0·706	0·329	0·308
		Berlin, 2000 Berlin ells per 1 Berlin Handelspfund.	0·54	0·638	0·524	0·66	0·308	0·288
		Cockerill, 2240 Berlin ells per 1 Berlin Handelspfund.	0·566	0·668	0·548	0·691	0·323	0·302
		French (Sedan), 1256 aunes per ½ kilo.	0·567	0·67	0·55	0·692	0·324	0·303
		French (Sedan), 1256 aunes per 1 Paris lb.	0·555	0·655	0·538	0·68	0·317	0·296
		French (Elbeuf), 3600 metres per ½ kilo.	0·235	0·278	0·228	0·288	0·134	0·126
Combed Yarn.		French, 600 aunes per ½ kilo.	1·177	1·389	1·14	1·439	0·671	0·628
Carded, Combed, Weft, Mohair, Alpaca, Cheviot Yarns.		English, 560 yards per 1 lb.	1·5	1·771	1·454	1·833	0·856	0·801
Linen, Tow, Hemp, Jute, Ramie Yarns.		English, 300 yards per 1 lb.	2·802	3·31	2·718	3·426	1·599	1·496
Vicuna and Carded Yarns.		Saxon, 780 Leipzig ells per 1 Zollpfund.	1·924	2·273	1·866	2·351	1·098	1·027
Shoddy Yarn.		German, 2000 Berlin ells per 1 Zollpfund.	0·635	0·9	0·615	0·776	0·362	0·339
Various.		Metric, 1000 metres per 1000 grams, or 500 metres per 500 grams.	1·693	2	1·642	2·07	0·966	0·904

0·54	1·442	1·734	1·852	1·768	1·763	1·803	4·252	0·85	0·667	0·357	0·52	1·578	0·59
0·457	1·22	1·467	1·568	1·497	1·493	1·527	3·6	0·72	0·564	0·302	0·44	1·334	0·5
0·557	1·489	1·787	1·91	1·823	1·818	1·859	4·385	0·877	0·687	0·368	0·533	1·625	0·609
0·39	1·178	1·418	1·516	1·447	1·444	1·475	3·479	0·695	0·545	0·292	0·425	1·289	0·484
0·835	2·53	3·036	3·246	3·098	3·09	3·159	7·45	1·49	1·168	0·625	0·911	2·761	1·035
0·893	2·704	3·246	3·47	3·312	3·303	3·377	7·965	1·593	1·249	0·668	0·973	2·951	1·106
1	3·028	3·635	3·886	3·709	3·694	3·783	8·92	1·78	1·399	0·749	1·09	3·305	1·239
0·33	1	1·2	1·284	1·225	1·221	1·251	2·945	0·589	0·462	0·247	0·36	1·091	0·409
0·275	0·833	1	1·069	1·02	1·018	1·041	2 454	0·491	0·385	0·206	0·3	0·909	0·341
0·257	0·779	0·935	1	0·955	0·952	0·973	2·295	0·459	0·36	0·193	0·281	0·851	0·319
0·27	0·816	0·98	1·048	1	0·997	1·02	2·405	0·481	0·377	0·202	0·294	0·891	0·334
0·27	0·818	0·982	1 05	1·003	1	1·022	2·411	0·482	0·377	0·202	0·295	0·894	0·335
0·264	0·799	0·961	1·027	0·98	0·978	1	2·358	0·472	0·369	0·198	0·288	0·874	0·328
0·112	0·34	0·408	0·435	0·416	0·414	0·424	1	0·2	0·157	0·084	0·122	0·371	0·139
0·561	1·696	2·037	2·178	2·079	2 074	2·12	5	1	0·785	0·42	0·611	1·853	0·694
0·715	2·165	2·6	2·778	2·652	2·645	2·704	6·377	1·275	1	0·535	0·779	2·363	0·886
1·336	4·038	4·856	5·191	4·955	4·942	5·046	11·917	2·383	1·868	1	1·456	4·416	1·655
0·917	2·778	3·334	3·564	3·402	3·393	3·47	8·182	1·636	1·283	0·687	1	3·032	1·136
0·302	0·916	1·1	1·176	1·122	1·119	1·144	2·699	0·54	0·423	0·226	0·33	1	0·375
0·807	2·445	2·934	3·137	2·994	2·986	3·053	7·2	1·44	1·129	0·604	0·88	2·668	1

These conversion factors apply solely to No. 1 yarn, but can be extended to any No. by multiplying the factor of the desired system by the yarn No. of the given system, *e.g.* :—

What German No. is the equivalent of Austrian shoddy yarn No. 4?

Answer: $0{\cdot}945 \times 4 = 3{\cdot}78$ (German yarn No.).

The conversion of yarn Nos. of other systems into the metric system (*i.e.*, 500 metres per 500 grams, or 1000 metres per 1000 grams), or *vice versâ*, is a simpler operation than that already described, all that is necessary being to divide the length (in metres) of the given hank by its own weight in grams; the product will be the conversion factor for No. 1 yarn in the metric system. For example: What metric yarn No. corresponds to English No. 20 weft (512 metres per 453·5 grams)?

$512 \div 453{\cdot}5 = 1{\cdot}129$ (factor) $\times 20 = 22{\cdot}58$; *i.e.*, English No. 20 is approximately equivalent to metric No. 23, and *vice versâ.*

The standard of weight employed in the desired system of numbering, divided by the standard weight of yarn (both expressed in metric values), gives the corresponding multiplying factor for No. 1 yarn for the desired system, *e.g.* :—

What is the equivalent of metric No. 20 yarn in English weft (basis 512 metres per $453\frac{1}{2}$ grams)?

$453{\cdot}5 \div 512 = 0{\cdot}885 \times 20 = 17{\cdot}72$, or in round numbers, 18; *i.e.*, No. 20 metric corresponds to about No. 18 English weft system.

In the foregoing manner, the entire series of calculations can be performed, and a number of these are reproduced in the preceding table. It may be mentioned that in all the yarn Nos. given in this table, equal weights imply equal lengths.

It thus becomes a very simple process to determine the numerical ratio between two yarns, by first ascertaining the

factor for No. 1, and then multiplying this on the given yarn No., *e.g.* :—

What metric yarn No. (No. = 1000 metres per 1 kilo., or 500 metres per $\frac{1}{2}$ kilo.) must be selected so as to obtain the same length and size as No. 30 Saxon-Vicuna yarn (= No. 1 = 440 metres per $\frac{1}{2}$ kilo.)?

Refer to the table and find the horizontal row corresponding to Saxon-Vicuna yarn, follow that until No. 1 is reached, and then seek out in the vertical column the line corresponding to the metric yarn system. This gives the number 0·88, *i.e.*, the weight, length and size of No. 1 Saxon and No. 0·88 metric are identical. As yarn No. 1 (Saxon) thus measures 880 metres per 1 kilo., No. 30 will contain 26,400 metres per kilo., *i.e.*, No. 26·4 metric is the equivalent of No. 30 Saxon-Vicuna yarn.

A few more tables are appended, in which the various whole-numbered metric yarns are calculated into their equivalents in other systems.

Comparative Tables of Various Systems.

On the basis of the metric system of numbering yarns, the Nos. rising by single units, and calculated to their equivalents in other systems.

In all Nos. equality of weight implies equality of yarn length.

	Cotton Yarn.				Carded Yarn.	
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	English, 840 yds. per 1 lb.	French, 1000 m. per ½ kilo.	German, 1151 Berlin ells per 1 Berlin Handelspfund.	Austrian, 1488 Viennese ells per 1 Viennese lb.	Saxon, 800 Leipzig ells per 1 Berlin Handelspfund.	Saxon, 800 Leipzig ells per 1 Zollpfund.
	I.	II.	III.	IV.	V.	VI.
1	0·590	0·500	0·609	0·484	1·035	1·106
2	1·180	1·000	1·218	0·968	2·070	2·212
3	1·770	1·500	1·827	1·452	3·105	3·318
4	2·360	2·000	2·436	1·936	4·140	4·424
5	2·950	2·500	3·045	2·420	5·175	5·530
6	3·540	3·000	3·654	2·904	6·210	6·636
7	4·130	3·500	4·263	3·388	7·245	7·742
8	4·720	4·000	4·872	3·872	8·280	8·848
9	5·310	4·500	5·481	4·356	9·315	9·954
10	5·900	5·000	6·090	4·840	10·350	11·060
11	6·490	5·500	6·699	5·324	11·385	12·166
12	7·080	6·000	7·308	5·808	12·420	13·272
13	7·670	6·500	7·917	6·292	13·455	14·378
14	8·260	7·000	8·526	6·776	14·490	15·484
15	8·850	7·500	9·135	7·260	15·525	16·590
16	9·440	8·000	9·744	7·744	16·560	17·696
17	10·030	8·500	10·353	8·228	17·595	18·802
18	10·620	9·000	10·962	8·712	18·630	19·908
19	11·210	9·500	11·571	8·196	19·665	21·014
20	11·800	10·000	12·180	9·680	20·700	22·120
21	12·390	10·500	12·789	10·164	21·735	23·226
22	12·980	11·000	13·398	10·648	22·770	24·332
23	13·570	11·500	14·007	11·132	23·805	25·438
24	14·160	12·000	14·616	11·616	24·840	26·544
25	14·750	12·500	15·225	12·100	25·875	27·650
26	15·340	13·000	15·834	12·584	26·910	28·756
27	15·930	13·500	16·443	13·068	27·945	29·862
28	16·520	14·000	17·052	13·552	28·980	30·968
29	17·110	14·500	17·661	14·036	30·015	32·074
30	17·700	15·000	18·270	14·520	31·050	33·180
31	18·290	15·500	18·879	15·004	32·085	34·286
32	18·880	16·000	19·488	15·488	33·120	35·392
33	19·470	16·500	20·097	15·972	34·155	36·498
34	20·060	17·000	20·706	16·456	35·190	37·604
35	20·650	17·500	21·315	16·940	36·225	38·710

	Cotton Yarn.				Carded Yarn.	
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	English, 840 yds. per 1 lb.	French, 1000 m. per ½ kilo.	German, 1151 Berlin ells per 1 Berlin Handelspfund.	Austrian, 1488 Viennese ells per 1 Viennese lb.	Saxon, 800 Leipzig ells per 1 Berlin Handelspfund.	Saxon, 800 Leipzig ells per 1 Zollpfund.
	I.	II.	III.	IV.	V.	VI.
36	21·240	18·000	21·924	17·424	37·260	39·816
37	21·830	18·500	22·533	17·908	38·295	40·922
38	22·420	19·000	23·142	18·392	39·330	42·028
39	23·010	19·500	23·751	18·876	40·365	43·134
40	23·600	20·000	24·360	19·360	41·400	44·240
41	24·190	20·500	24·969	19·844	42·435	45·346
42	24·780	21·000	25·578	20·328	43·470	46·452
43	25·370	21·500	26·187	20·812	44·505	47·558
44	25·960	22·000	26·796	21·296	45·540	48·664
45	26·550	22·500	27·405	21·780	46·575	49·770
46	27·140	23·000	28·014	22·264	47·610	50·876
47	27·730	23·500	28·623	22·748	48·645	51·982
48	28·320	24·000	29·232	23·232	49·680	53·088
49	28·910	24·500	29·841	23·716	50·715	54·194
50	29·500	25·000	30·450	24·200	51·750	55·300
51	30·090	25·500	31·059	24·684	52·785	56·406
52	30·680	26·000	31·668	25·168	53·820	57·512
53	31·270	26·500	32·277	25·652	54·855	58·618
54	31·860	27·000	32·886	26·136	55·890	59·724
55	32·450	27·500	33·495	26·620	56·925	60·830
56	33·040	28·000	34·104	27·104	57·960	61·936
57	33·630	28·500	34·713	27·588	58·995	63·042
58	34·220	29·000	35·322	28·072	60·030	64·148
59	34·810	29·500	35·931	28·556	61·065	65·254
60	35·400	30·000	36·540	29·040	62·100	66·360
61	35·990	30·500	37·149	29·524	63·135	67·466
62	36·580	31·000	37·758	30·008	64·170	68·572
63	37·170	31·500	38·367	30·492	65·205	69·678
64	37·760	32·000	38·976	30·976	66·240	70·784
65	38·350	32·500	39·585	31·460	67·275	71·890
66	38·940	33·000	40·194	31·944	68·310	72·996
67	39·530	33·500	40·803	32·428	69·345	74·102
68	40·120	34·000	41·412	32·912	70·380	75·208
69	40·710	34·500	42·021	33·396	71·415	76·314
70	41·300	35·000	42·630	33·880	72·450	77·420

	Cotton Yarn.				Carded Yarn.	
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	English, 840 yds. per 1 lb.	French, 1000 m. per ½ kilo.	German, 1151 Berlin ells per 1 Berlin Handelspfund.	Austrian, 1488 Viennese ells per 1 Viennese lb.	Saxon, 800 Leipzig ells per 1 Berlin Handelspfund.	Saxon, 800 Leipzig ells per 1 Zollpfund.
	I.	II.	III.	IV.	V.	VI.
71	41·890	35·500	43·239	34·364	73·485	78·526
72	42·480	36·000	43·848	34·848	74·520	79·632
73	43·070	36·500	44·457	35·332	75·555	80·738
74	43·660	37·000	45·066	35·816	76·590	81·844
75	44·250	37·500	45·675	36·300	77·625	82·950
76	44·840	38·000	46·284	36·784	78·660	84·056
77	45·430	38·500	46·893	37·268	79·695	85·162
78	46·020	39·000	47·502	37·752	80·730	86·268
79	46·610	39·500	48·111	38·236	81·765	87·374
80	47·200	40·000	48·720	38·720	82·800	88·480
81	47·790	40·500	49·329	39·204	83·835	89·586
82	48·380	41·000	49·938	39·688	84·870	90·692
83	48·970	41·500	50·547	40·172	85·905	91·798
84	49·560	42·000	51·156	40·656	86·940	92·204
85	50·150	42·500	51·765	41·140	87·975	94·010
86	50·740	43·000	52·374	41·624	89·010	95·116
87	51·330	43·500	52·983	42·108	90·045	96·222
88	51·920	44·000	53·592	42·592	91·080	97·328
89	52·510	44·500	54·201	43·076	92·115	98·434
90	53·100	45·000	54·810	43·560	93·150	99·540
91	53·690	45·500	55·419	44·044	94·185	100·646
92	54·280	46·000	56·028	44·528	95·220	101·752
93	54·870	46·500	56·637	45·012	96·255	102·858
94	55·460	47·000	57·246	45·496	97·290	103·964
95	56·050	47·500	57·855	45·980	98·325	105·070
96	56·640	48·000	58·464	46·464	99·360	106·176
97	57·230	48·500	59·073	46·948	100·395	107·282
98	57·820	49·000	59·682	47·432	101·430	108·388
99	58·410	49·500	60·291	47·916	102·465	109·494
100	59·000	50·000	60·900	48·400	103·500	110·600

	Carded Yarn.					
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	Austrian, 565 Viennese ells per 1 Viennese lb.	Austrian, 1760 Viennese ells per 1 Viennese lb.	Prussian, 2059 Berlin ells per 1 Berlin Handelspfund, or 2200 Berlin ells per 1 Zollpfund.	Berlin, 2200 Berlin ells per 1 Berlin Handelspfund.	Cockerill, 2240 Berlin ells per 1 Berlin Handelspfund.	French (Sedan), 1256 aunes per ½ kilo.
	VII.	VIII.	IX.	X.	XI.	XII.
1	1·239	0·409	0·341	0·319	0·334	0·335
2	2·478	0·818	0·682	0·638	0·668	0·670
3	3·717	1·227	1·023	0·957	1·002	1·005
4	4·956	1·736	1·364	1·276	1·337	1·340
5	6·195	2·145	1·705	1·595	1·670	1·675
6	7·434	2·554	2·046	1·914	2·004	2·010
7	8·673	2·963	2·387	2·233	2·338	2·345
8	9·912	3·372	2·728	2·552	2·672	2·680
9	11·151	3·781	3·069	2·871	3·006	3·015
10	12·390	4·190	3·410	3·190	3·340	3·350
11	13·629	4·599	3·751	3·509	3·674	3·685
12	14·868	5·008	4·092	3·828	4·008	4·020
13	16·107	5·417	4.433	4·417	4·342	4·355
14	17·346	5·626	4·774	4·466	4·676	4·690
15	18·585	6·035	5·115	4·785	5·010	5·025
16	19·824	6·444	5·456	5·104	5·344	5·360
17	21·063	6·853	5·797	5·423	5·678	5·695
18	22·302	7·362	6·138	5·742	6·012	6·030
19	23·541	7·771	6·479	6·061	6·346	6·365
20	24·780	8·180	6·820	6·380	6·680	6·700
21	26·019	8·589	7·161	6·699	7·014	7·035
22	27·258	8·998	7·502	7·018	7·348	7·370
23	28·497	9·407	7·843	7·337	7·682	7·705
24	29·736	9·816	8·184	7·656	8·016	8·040
25	30·975	10·225	8·525	7·975	8·350	8·375
26	32·214	10·634	8·866	8·294	8·684	8·710
27	33·453	11·043	9·207	8·613	9·018	9·045
28	34·692	11·452	9·548	8·932	9·352	9·380
29	35·931	11·861	9·889	9·251	9·686	9·715
30	37·170	12·270	10·230	9·570	10·020	10·050
31	38·409	12·679	10·571	9·889	10·354	10·385
32	39·648	13·088	10·912	10·208	10·688	10·720
33	40·887	13·497	11·253	10·527	11·022	11·055
34	42·126	13·906	11·594	10·846	11·356	11·390
35	43·365	14·315	11·935	11·165	11·690	11·725

	Carded Yarn.					
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	Austrian, 565 Viennese ells per 1 Viennese lb.	Austrian, 1760 Viennese ells per 1 Viennese lb.	Prussian, 2059 Berlin ells per 1 Handelspfund, or 2200 Berlin ells per 1 Zollpfund.	Berlin, 2200 Berlin ells per 1 Berlin Handelspfund.	Cockerill, 2240 Berlin ells per 1 Berlin Handelspfund.	French (Sedan) 1256 aunes per ½ kilo.
	VII.	VIII.	IX.	X.	XI.	XII.
36	44·604	14·724	12·276	11·484	11·024	12·060
37	45·843	15·133	12·617	11·803	12·358	12·395
38	47·082	15·542	12·958	12·122	12·692	12·730
39	48·321	15·951	13·299	12·441	13·026	13·065
40	49·560	26·360	13·640	12·760	13·360	13·400
41	50·799	16·769	13·981	13·079	13·694	13·735
42	52·038	17·178	14·322	13·398	14·028	14·070
43	53·277	17·587	14·663	13·717	14·362	14·405
44	54·516	17·996	15·004	14·036	14·696	14·740
45	55·755	18·405	15·345	14·355	15·030	15·075
46	56·994	18·814	15·686	14·674	15·364	15·410
47	58·233	19·223	16·027	14·993	15·698	15·745
48	59·472	19·632	16·368	15·312	16·032	16·080
49	60·711	20·041	16·709	15·631	16·366	16·415
50	61·950	20·450	17·050	15·950	16·700	16·750
51	63·189	20·859	17·391	16·269	17·034	17·085
52	64·428	21·268	17·732	16·588	17·368	17·420
53	65·667	21·677	18·073	16·907	17·702	17·755
54	66·906	22·086	18·414	17·226	18·036	18·090
55	68·145	22·495	18·755	17·545	18·370	18·425
56	69·384	22·904	19·096	17·864	18·704	18·760
57	70·623	23·313	19·437	18·183	19·038	19·095
58	71·862	23·722	19·778	18·502	19·372	19·430
59	73·101	24·131	20·119	18·821	19·706	19·765
60	74·340	24·540	20·460	19·140	20·040	20·100
61	75·579	24·949	20·801	19·459	20·374	20·435
62	76·818	25·358	21·142	19·778	20·708	20·770
63	78·057	25·767	21·483	20·097	21·042	21·105
64	79·296	26·176	21·824	20·416	21·376	21·440
65	80·535	26·585	22·165	20·735	21·710	21·775
66	81·774	26·994	22·506	21·054	22·044	22·110
67	83·013	27·403	22·847	21·373	22·378	22·445
68	84·252	27·812	23·188	21·692	22·712	22·780
69	85·491	28·221	23·529	22·011	23·046	23·115
70	86·730	28·630	23·870	22·330	23·380	23·450

	Carded Yarn.					
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	Austrian, 565 Viennese ells per 1 Viennese lb.	Austrian, 1760 Viennese ells per 1 Viennese lb.	Prussian, 2059 Berlin ells per 1 Berlin Handelspfund, or 2200 Berlin ells per 1 Zollpfund.	Berlin, 2200 Berlin ells per 1 Berlin Handelspfund.	Cockerill, 2240 Berlin ells per 1 Berlin Handelspfund.	French (Sedan), 1256 aunes per ½ kilo.
	VII.	VIII.	IX.	X.	XI.	XII.
71	87·979	29·039	24·211	22·649	23·714	23·785
72	89·208	29·448	24·552	22·968	24·048	24·120
73	90·447	29·857	24·893	23·287	24·382	24·455
74	91·686	30·226	25·234	23·606	24·716	24·790
75	92·925	30·675	25·575	23·925	25·050	25·125
76	94·164	31·084	25·916	24·244	25·384	25·460
77	95·403	31·493	26·257	24·563	25·718	25·795
78	96·642	31·902	26·598	24·882	26·052	26·130
79	97·881	32·311	26·939	25·201	26·386	26·465
80	99·120	32·720	27·280	25·520	26·720	26·800
81	100·359	33·139	27·621	25·839	27·054	27·135
82	101·598	33·538	27·962	26·158	27·388	27·470
83	102·837	33·947	28·303	26·477	27·722	27·805
84	104·076	34·356	28·644	26·796	28·056	28·140
85	105·315	34·765	28·985	27·115	28·390	28·475
86	106·554	35·174	29·326	27·434	28·724	28·810
87	107·793	35·583	29·667	27·753	29·058	29·145
88	109·032	35·992	30·008	28·072	29·392	29·480
89	110·271	36·401	30·349	28·391	29·726	29·815
90	111·510	36·810	30·690	28·710	30·060	30·150
91	112·749	37·219	31·031	29·029	30·394	30·485
92	113·988	37·628	31·372	29·348	30·728	30·820
93	115·227	38·037	31·713	29·667	31·062	31·155
94	116·466	38·446	32·054	29·986	31·396	31·490
95	117·705	38·855	32·395	30·305	31·730	31·825
96	118·944	39·264	32·736	30·624	32·064	32·160
97	120·183	39·673	33·077	30·943	32·398	32·495
98	121·422	40·082	33·418	31·262	32·732	32·830
99	122·661	40·491	33·759	31·581	33·066	33·165
100	123·900	40·900	34·100	31·900	33·400	33·500

	Carded Yarn.		Combed Yarn.	Carded, Combed, Weft, Mohair, Alpaca and Cheviot Yarn.	Linen, Tow, Hemp, Jute and Ramie Yarn.	Vicuna and Carded Yarn.
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	French (Sedan), 1256 aunes per 1 Paris lb.	French (Elbeuf), 3600 m. per ½ kilo.	French, 600 aunes per ½ kilo.	English, 560 yards per 1 lb.	English, 300 yards per 1 lb.	Saxon, 780 Leipzig ells per 1 Zollpfund.
	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
1	0·328	0·139	0·694	0·886	1·655	1·136
2	0·656	0·278	1·388	1·772	3·310	2·272
3	0·984	0·417	2·082	2·658	4·965	3·408
4	1·312	0·556	2·776	3·544	6·620	4·544
5	1·640	0·695	3·470	4·430	8·275	5·680
6	1·968	0·834	4·164	5·316	9·930	6·816
7	2·296	0·973	4·858	6·202	11·585	7·952
8	2·624	1·112	5·552	7·088	13·240	9·088
9	2·952	1·251	6·246	7·974	14·895	10·224
10	3·280	1·390	6·940	8·860	16·550	11·360
11	3·608	1·529	7·634	9·746	18·205	12·496
12	3·936	1·668	8·328	10·632	19·860	13·632
13	4·264	1·807	9·022	11·518	21·515	14·768
14	4·592	1·946	9·716	12·404	23·170	15·904
15	4·920	2·085	10·410	13·290	24·825	17·040
16	5·248	2·224	11·104	14·176	26·480	18·176
17	5·576	2·363	11·798	15·062	28·135	19·312
18	5·904	2·502	12·492	15·948	29·790	20·448
19	6·232	2·641	13·186	16·834	31·445	21·584
20	6·560	2·780	13·880	17·720	33·100	22·720
21	6·888	2·919	14·574	18·606	34·755	23·856
22	7·216	3·058	15·268	19·492	36·410	24·992
23	7·544	3·197	15·962	20·378	38·065	26·128
24	7·872	3·336	16·656	21·264	39·720	27·264
25	8·200	3·475	17·350	22·150	41·375	28·400
26	8·528	3·614	18·044	23·036	43·030	29·536
27	8·856	3·753	18·738	23·922	44·685	30·672
28	8·184	3·892	19·432	24·808	46·340	31·808
29	9·512	4·031	20·126	25·694	47·995	32·944
30	9·840	4·170	20·820	26·580	49·650	34·080
31	10·168	4·309	21·514	27·466	51·305	35·216
32	10·496	4·448	22·208	28·352	52·960	36·352
33	10·824	4·587	22·902	29·238	54·615	37·488
34	11·152	4·726	23·596	30·124	56·270	38·624

	Carded Yarn.		Combed Yarn.	Carded, Combed, Weft, Mohair, Alpaca and Cheviot Yarn.	Linen, Tow, Hemp, Jute and Ramie Yarn.	Vicuna and Carded Yarn.
Metric, 1000 m. per 1 kilo, or 500 m. per $\frac{1}{2}$ kilo.	French (Sedan), 1256 aunes per 1 Paris lb.	French (Elbeuf), 3600 m. per $\frac{1}{2}$ kilo.	French, 600 aunes per $\frac{1}{2}$ kilo.	English, 560 yards per 1 lb.	English, 300 yards per 1 lb.	Saxon, 780 Leipzig ells per 1 Zollpfund.
	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
35	11·480	4·865	24·290	31·010	57·925	39·760
36	11·808	5·004	24·984	31·896	59·580	40·896
37	12·136	5·143	25·678	32·782	61·235	42·032
38	12·464	5·282	26·372	33·668	62·890	43·168
39	12·792	5·421	27·066	34·554	64·545	44·304
40	13·120	5·560	27·760	35·440	66·200	45·440
41	13·448	5·699	28·454	36·326	67·855	46·576
42	13·776	5·838	29·148	37·212	69·510	47·712
43	14·104	5·977	29·842	38·098	71·165	48·848
44	14·432	6·116	30·536	38·984	72·820	49·984
45	14·760	6·255	31·230	39·870	74·475	51·120
46	15·088	6·394	31·924	40·756	76·130	52·256
47	15·416	6·533	32·618	41·642	77·785	53·392
48	15·744	6·672	33·312	42·528	79·440	54·528
49	16·072	6·811	34·006	43·414	81·095	55·664
50	16·400	6·950	34·700	44·300	82·750	56·800
51	16·728	7·099	35·394	45·186	84·405	57·936
52	17·056	7·228	36·088	46·072	86·060	59·072
53	17·384	7·367	36·782	46·958	87·715	60·208
54	17·712	7·506	37·476	47·844	89·370	61·344
55	18·040	7·645	38·170	48·730	91·025	62·480
56	18·368	7·784	38·864	49·616	92·680	63·616
57	18·696	7·923	39·558	50·502	94·335	64·752
58	19·024	8·062	40·252	51·388	95·990	65·888
59	19·352	8·201	40·946	52·274	97·645	67·024
60	19·680	8·340	41·640	53·160	99·300	68·160
61	20·008	8·479	42·334	54·046	100·955	69·296
62	20·336	8·618	43·028	54·932	102·610	70·432
63	20·664	8·757	43·722	55·818	104·265	71·568
64	20·992	8·896	44·416	56·704	105·920	72·704
65	21·320	9·035	45·110	57·590	107·575	73·840
66	21·648	9·174	45·804	58·476	109·230	74·976
67	21·976	9·313	46·498	59·362	110·885	76·112
68	22·304	9·452	47·192	60·248	112·540	77·248

	Carded Yarn.		Combed Yarn.	Carded, Combed, Weft, Mohair, Alpaca and Cheviot Yarn.	Linen, Tow, Hemp, Jute and Ramie Yarn.	Vicuna and Carded Yarn.
Metric, 1000 m. per 1 kilo, or 500 m. per ½ kilo.	French (Sedan), 1256 aunes per 1 Paris lb.	French (Elbeuf), 3600 m. per ½ kilo.	French, 600 aunes per ½ kilo.	English, 560 yards per 1 lb.	English, 300 yards per 1 lb.	Saxon, 780 Leipzig ells per 1 Zollpfund.
	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
69	22·632	9·591	47·886	61·134	114·195	78·384
70	22·960	9·730	48·580	62·020	115·850	79·520
71	23·288	9·869	49·274	62·906	117·505	80·656
72	23·616	10·008	49·968	63·792	119·160	81·792
73	23·944	10·107	50·662	64·678	120·815	82·928
74	24·272	10·286	51·356	65·564	122·470	84·064
75	24·600	10·425	52·050	66·450	124·125	85·200
76	24·928	10·564	52·744	67·336	125·780	86·336
77	25·256	10·703	53·438	68·222	127·435	87·472
78	25·584	10·842	54·132	69·108	129·090	88·608
79	25·912	10·981	54·826	69·994	130·745	89·744
80	26·240	11·120	55·520	70·880	132·400	90·880
81	26·568	11·259	56·214	71·766	134·055	92·016
82	26·896	11·398	56·908	72·652	135·710	93·152
83	27·224	11·537	57·602	73·538	137·365	94·288
84	27·552	11·676	58·296	74·424	139·020	95·424
85	27·880	11·815	58·990	75·310	140·675	96·560
86	28·208	11·954	59·684	76·196	142·330	97·696
87	28·536	12·093	60·378	77·082	143·985	98·832
88	28·864	12·232	61·072	77·968	145·640	99·968
89	29·192	12·371	61·766	78·854	147·295	101·104
90	29·520	12·510	62·460	79·740	148·950	102·240
91	29·848	12·649	63·154	80·626	150·605	103·376
92	30·176	12·788	63·848	81·512	152·260	104·512
93	30·504	12·927	64·542	82·398	153·915	105·648
94	30·832	13·066	65·236	83·284	155·570	106·784
95	31·160	13·205	65·930	84·170	157·225	107·920
96	31·488	13·344	66·624	85·096	158·880	109·056
97	31 816	13·483	67·318	85·942	160·535	110·192
98	32·144	13·622	68·012	86·828	162·190	111·328
99	32·472	13·761	68·706	87·714	163·845	112·464
100	32·800	13·900	69·400	88·600	165·500	113·600

By means of the foregoing tables it is easy to see at once which No. of any other system corresponds in weight and length to a given metric yarn No., *e.g.* :—

What English weft No. is equivalent to metric No. 10?

On turning to the table and finding metric No. 10, the column numbered xvi. will give the No. 8·860, *i.e.*, 1 kilo. of yarn, metric No. 10, and the same weight (2·2 lb.) of English weft No. 8·860 will contain an equal length of yarn, *viz.*, 10,000 metres (10,936 yards).

Conversely, to ascertain the relation between a given No. of yarn (whole number) in any system and the metric system, the form of calculation given on p. 110 is employed.

Weights and Measures.

1 Austrian or Vienna ell	=	0·7775586	metres	=30·6	inches.
1 Prussian or Berlin ,,	=	0·66694	,,	=26·26	,,
1 Saxon or Leipzig ,,	=	0·565	,,	=22·25	,,
1 French or Parisian ,,	=	1·188446	,,	=46·79	,,
1 English yard	=	0·91439179	,,	=36	,,

1 Austrian or Viennese lb.	=	560·060	grams	=1·23	lb.
1 Prussian or Berlin Handelspfund (lb.)	=	467·711	,,	=1·03	,,
1 German or Zollpfund (lb.)	=	500	,,	=1·1	,,
1 French or Parisian ,,	=	489·5058	,,	=1·08	,,
1 English ,,	=	453·59265	,,	=1	,,

Calculating the Weight of Linen Yarn.

In all yarns, except linens, the bundles packed for shipment are of constant weight, and the length of yarn in the bundle varies with the No.

In the case of linen yarns, however, the converse practice obtains, the length of yarn in a pack being invariable, whereas the weight alters in conformity with the yarn No.

To determine the weight of a pack of any given yarn No., proceed as follows :—

In the case of systems where, *e.g.*, the number of lays

going to 1 lb. gives the yarn No., the given yarn No. is divided into the number of leas in the pack, and the answer will give the weight of the latter.

For example: Yarn No. 30 (English) contains 2400 leas, and therefore weighs 2400 ÷ 30 = 80 lb. per pack.

To find the weight in kilos, the number of leas in a pack is multiplied by the equivalent of 1 lb. in grams, and the product divided by the yarn No., *e.g.* :—

lays, 2400 × 453·5 (grams) = 1088·4 ÷ 30 = 36·28 kilos

as the weight of a pack of No. 30 yarn.

Austrian linen yarns are calculated to kilos as follows:—

The number of hanks per "Schock" (pack) is multiplied by the metric equivalent of 10 lb. English (*i.e.*, 4·535 kilos), and the product is divided by the yarn No., *e.g.*,

hanks, 240 × 4·535 kilos = 1088·400 ÷ 30 = 36·28 kilos

as the weight of the pack.

The following constants are used in weight calculations:—

English	system	for calculating	to English	lb.,	2400
,,	,,	,,	,,	kilos,	1088·4
Austrian	,,	,,	,,	,,	1088·4

i.e., any given yarn No. divided into one or other of these figures gives the weight of a pack.

The relative weights of the various linen yarn Nos. are given in the subjoined table. It may be observed that the linen yarns spun in Austria range from No. 6 to No. 70, sometimes up to No. 150, whereas, still finer grades, up to No. 300, are spun by British makers.

The coarse Nos. rise by two's from No. 6 to about No. 40; the finer yarns, from 40 upwards, rising by fives, and the finest of all by tens.

Weights of Linen Yarns.

(*a*) *English System.*

1 pack = 720,000 yards or 658,362 metres.

Yarn No.	Weight per Pack.		Yarn No.	Weight per Pack.	
	Lb.	Kilos.		Lb.	Kilos.
	Constant, 2400.	Constant, 1088·4.		Constant, 2400.	Constant, 1088·4.
6	400	181·400	135	$17^7/_9$	8·062
8	300	136·050	140	$17^1/_7$	7·774
10	240	108·840	145	$16^{16}/_{29}$	7·506
12	200	90·700	150	16	7·256
14	$171^3/_7$	77·743	155	$15^{15}/_{31}$	7·022
16	150	68·025	160	15	6·802
18	$133^1/_3$	60·467	165	$14^6/_{11}$	6·596
20	120	54·420	170	$14^2/_{17}$	6·402
22	$109^1/_{11}$	49·473	175	$13^5/_7$	6·219
24	100	45·350	180	$13^1/_3$	6·047
26	$92^4/_{13}$	41·862	185	$12^{36}/_{37}$	5·883
28	$85^5/_7$	38·871	190	$12^{12}/_{19}$	5·728
30	80	36·280	195	$12^4/_{13}$	5·582
32	75	34·012	200	12	5·442
35	$68^4/_7$	31·097	205	$11^{29}/_{41}$	5·309
40	60	27·210	210	$11^3/_7$	5·183
45	$53^1/_3$	24·187	215	$11^7/_{43}$	5·062
50	48	21·768	220	$10^{10}/_{11}$	4·895
55	$43^7/_{11}$	19·789	225	$10^2/_3$	4·837
60	40	18·140	230	$10^{10}/_{23}$	4·732
65	$36^{12}/_{13}$	16·745	235	$10^{20}/_{47}$	4·631
70	$34^2/_7$	15·550	240	10	4·535
75	32	14·512	245	$9^{39}/_{49}$	4·442
80	30	13·605	250	$9^3/_5$	4·354
85	$28^4/_{17}$	12·805	255	$9^7/_{17}$	4·269
90	$26^2/_3$	12·094	260	$9/^3_{13}$	4·186
95	$25^5/_{19}$	11·457	265	$9^3/_{53}$	4·107
100	24	10·884	270	$8^8/_9$	4·031
105	$22^6/_7$	10·366	275	$8^8/_{11}$	3·958
110	$21^9/_{11}$	9·895	280	$8^4/_7$	3·887
115	$20^{20}/_{23}$	9·464	285	$8^8/_{19}$	3·819
120	20	9·070	290	$8^8/_{29}$	3·753
125	$19^1/_5$	8·707	295	$8^8/_{59}$	3·689
130	$18^6/_{13}$	8·372	300	8	3·628

(b) Austrian System.

1 Schock (pack) = 864,000 Viennese ells = 671,810 metres = 734,707 yards.

Constant: for kilo = 1088·4.

Particulars of Carded Yarn.

Old Austrian System.

From the information already given, it is evident in the Austrian system of numbering carded yarn, the yarn No. is indicated by the number of hanks (Stück)—of 1760 Viennese ells = 1369 metres = 1496·3 yards—going to 1 Viennese lb. (= 560 grams = 1·23).

Thus, for example, if 1760 Viennese ells of yarn weigh 1 Viennese lb., the yarn is No. 1; if 1760 × 2 ells weigh 1 Viennese lb., No. 2, and so on; the length of the yarn increasing by 1760 Viennese ells for each ascending No.

In some Continental weaving districts, where the yarn is wound in "cops" (Schleifeln, Kötzer), containing varying lengths of yarn, the size is expressed in "Loth" (= $\frac{1}{32}$ of the German lb. = 17·5 grams = 0·616 oz.), or, nowadays, more frequently in grams, so that one hears of 24-, 20-, 16-, 10-"loth" yarn. For example, 4-"loth" warp is also known as "60-gram warp"; 10-"loth" weft as "175-gram weft," and so on.

1 Austrian lb. contains 32 "Loth," each equal to 17·5 grams, so that a 32-"loth" yarn—which weighs 560 grams—means that 1760 Viennese ells go to that weight, and it is therefore a No. 1 yarn. A 20-"loth" yarn weighs 350 grams, and, consequently, is No. $1\frac{3}{5}$, *i.e.*, $1\frac{3}{5} \times 1760$ Viennese ells (= 2816 Viennese ells, 2190·4 metres, or 2394 yards) are required to make up the weight of 560 grams (1·23 lb.)

This explanation shows, that by dividing either the indicated number of "Loth" into 32, or the number of grams into 560 (= 1 Austrian lb.), the hank No. of the yarn can

be ascertained; and by multiplying this quotient by 1760 Viennese ells, or by 1369 metres, the answer obtained gives the number of Viennese ells, or of metres, of the given yarn No. in 1 Viennese lb.

In fine yarns—low "Loth" Nos.—the difference between two consecutive whole Nos. is too great for practical use, so that intermediate Nos., *e.g.*, $4\frac{1}{4}$-, $4\frac{1}{2}$-, $4\frac{3}{4}$-"loth," and such like, have to be employed.

In the subjoined table nearly the whole series of yarn Nos. expressed on the "Loth" basis is given, with the corresponding weights in grams, hank Nos., and international metric Nos.

Comparative Table for Carded Yarn.

Austrian System.

1 Stück (hank) = 1760 Viennese ells, 1369 metres, or 1497·7 yards. Basis of weight, 1 Viennese lb. = 560 grams = 1·23 lb.

Weight per Hank.		Yarn No. in Hanks.	Metric No.	Weight per Hank.		Yarn No. in Hanks.	Metric No.
In Loth.	In Grms.[1]			In Loth.	In Grms.[1]		
32	560	1	2·445	$8^1/_2$	149	$3^{13}/_{17}$	9·205
31	542	$1^1/_{31}$	2·524	$8^1/_4$	144	$3^{29}/_{33}$	9·484
30	525	$1^1/_{15}$	2·608	8	140	4	9·780
29	507	$1^3/_{29}$	2·698	$7^3/_4$	136	$4^4/_{31}$	10·095
28	490	$1^1/_7$	2·794	$7^1/_2$	131	$4^4/_{15}$	10·432
27	472	$1^5/_{27}$	2·898	$7^1/_4$	127	$4^{12}/_{29}$	10·792
26	455	$1^3/_{13}$	3·009	7	122	$4^4/_7$	11·177
25	437	$1^7/_{25}$	3·130	$6^3/_4$	118	$4^{20}/_{27}$	11·591
24	420	$1^1/_3$	3·260	$6^1/_2$	114	$4^{12}/_{13}$	12·037
23	402	$1^9/_{23}$	3·400	$6^1/_4$	109	$5^3/_{25}$	12·518
22	385	$1^5/_{11}$	3·556	6	105	$5^1/_3$	13·040
21	367	$1^{11}/_{21}$	3·726	$5^3/_4$	101	$5^{13}/_{23}$	13·607
20	350	$1^3/_5$	3·912	$5^1/_2$	96	$5^4/_{11}$	14·225
19	332	$1^{13}/_{19}$	4·118	$5^1/_4$	92	$6^2/_{21}$	14·903
18	315	$1^7/_9$	4·347	5	87	$6^2/_5$	15·648
17	297	$1^{15}/_{17}$	4·602	$4^3/_4$	83	$6^{14}/_{19}$	16·472
16	280	2	4·890	$4^1/_2$	79	$7^1/_9$	17·387
15	262	$2^2/_{15}$	5·216	$4^1/_4$	74	$7^9/_{17}$	18·409
14	245	$2^2/_7$	5·589	4	70	8	19·560
13	227	$2^6/_{13}$	6·018	$3^3/_4$	66	$8^8/_{15}$	20·864
12	210	$2^2/_3$	6·520	$3^1/_2$	61	$9^1/_{17}$	22·354
11	192	$2^{10}/_{11}$	7·113	$3^1/_4$	57	$9^{11}/_{13}$	24·074
10	175	$3^1/_5$	7·824	3	52	$10^2/_3$	26·080
$9^3/_4$	171	$3^{11}/_{39}$	8·025	$2^3/_4$	48	$11^7/_{11}$	28·451
$9^1/_2$	166	$3^7/_{19}$	8·236	$2^1/_2$	44	$12^4/_5$	31·296
$9^1/_4$	162	$3^{17}/_{37}$	8·458	$2^1/_4$	39	$14^2/_9$	34·773
9	157	$3^5/_9$	8·693	2	35	16	39·120
$8^3/_4$	153	$3^{23}/_{35}$	8·942				

Note.—The "metric No." in this table implies that a corresponding number of metres go in each case to the kilo, *e.g.*,

[1] 28·4 grams = 1 oz.; so the figures in this column when divided by that factor, give the weight in ozs.

No. 16 (hank No.) is equivalent to No. 39·120 metric, and, consequently, contains 39,120 metres per 1 kilo.

In reckoning the grams, the fractions from $\frac{1}{10}$ to $\frac{5}{10}$ are disregarded, whilst those between $\frac{6}{10}$ and $\frac{9}{10}$ are counted as 1 gram.

The Number or "Titre" of True Silk.

The system of numbering pursued for silk differs from that for all other yarns, and is based on a constant length and variable weight. The higher the number or "titre" of the silk the coarser the thread.

The No. is expressed in so-called "deniers".

Of the different methods adopted, the following are the chief:—

1. *International (French) Titre.*

Here the titre is either the weight of 10,000 metres in grams,
or ,, 500 ,, deniers.
1 denier = 0·050 gram (or $\frac{1}{20}$ gram) = 0·771 grain.

2. *New Lyons (French) Titre.*

The titre = the weight of 12,000 metres in deniers,
or ,, 500 ,, "gran".
1 denier = $\frac{1}{384}$ lb. (French) or 1·2747 grams (=19·66 grains or 0·044 oz.).
1 gran = $\frac{1}{9216}$,, 0·0531 ,, (= 0·819 grain).
1 Paris lb. = 16 oz. of 24 deniers = 384 deniers of 24 gran = 9216 gran
= 489·5064 grams = 1·078 lb.

3. *Old Lyons Titre.*

The titre = the weight of 9600 aunes or Paris ells (= 11,409 metres or 12,470 yards) in deniers, or the weight of 400 aunes (= 475$\frac{3}{8}$ metres or 519·6 yards) in gran.

Deniers and grans have the same value as in System 2.

4. *Turin Titre (Titolo legale).*

The titre is the weight of 9000 metres in grams, or
,, ,, 450 ,, deniers.
1 denier (denaros) = 0·05 grams or $\frac{1}{20}$ gram.

5. *Milan Titre* (*Titolo Milanese*).

The titre is the weight of 9600 aunes in deniers, or
,, ,, 400 ,, gran.
1 denier $= \frac{1}{192}$ part of the Milan gold mark $= 1\cdot224$ grams $= 0\cdot0431$ oz.
1 gran $= \frac{1}{4608}$,, ,, $= 0\cdot051$,, ($0\cdot778$ grain).
The gold mark weighs 8 oz. of 24 deniers $= 192$ deniers of 24 gran $=$ 4608 gran $= 235$ grams $= 8\cdot274$ oz.

6. *Piedmont Titre* (*Titolo Piemontese*).

The standards of measurement are the same as in the Milan titre, but the weights are based on the Turin lb. :—

1 denier $= \frac{1}{288}$ of 1 Turin lb. $= 1\cdot2736$ grams $= 19\cdot65$ grains or $0\cdot045$ oz.
1 gran $= \frac{1}{6912}$,, $= 0\cdot0534$,, $= 0\cdot8238$ grain.
1 Turin lb. $= 12$ oz. of 24 deniers $= 288$ deniers of 24 gran $= 6912$ gran $= 368\cdot8$ grams $= 12\cdot98$ oz.

Example.

(*International System*).

If 10,000 metres weigh 30 grams, 500 metres of the same silk will weigh $\frac{30}{20} = 1\frac{1}{2}$ grams, and as this is equal to 30 deniers, the silk is No. 30 denier yarn.

In determining the titre, a fine indicating balance is employed; and since the cocoon thread is uneven, several leas (of 500 metres) are unreeled, the heaviest and lightest being taken as the average denier No.

Thus, supposing the lightest lea to weigh 28 and the heaviest 30 deniers, the titre is expressed as 28/30 deniers, *i.e.*, the silk is not lighter than 28 nor heavier than 30 deniers.

The titre of silk ranges between 11 and 90 deniers, and one and the same silk may vary by as much as 10 deniers; *e.g.*, 12/14, 24/26, 32/35, 40/45, 56/62, 70/80, and so on, especially in the coarser Nos.

Silk being extremely hygroscopic, or absorbent of atmospheric moisture, public conditioning-houses are established,

under State control, at the chief centres of the trade, to enable the true weight of silk threads to be determined with accuracy. Here the samples on which sales are concluded are dried at 110° C., in a special apparatus,[1] and then weighed in a heated atmosphere. The percentage of moisture is about 11 °/₀.

The following classes of silk yarn are met with in commerce, the differences consisting in the degree and direction of twist (right- or left-handed), and in the number of component cocoon threads employed in the manufacture :—

1. Grège, or raw silk. This contains 3 to 12 cocoon thread slightly twisted.

2. Organzine, or warp silk, prepared by very closely twisting (60 to 80 turns per 1 c.m., *i.e.*, 150 to 200 per inch) 2 to 3 raw silk threads from the best (most uniform) cocoons; hence the name double or three-ply organzine.

3. Trama, or silk weft, characterised by a much lighter degree of twist, prepared from 2 to 3 raw silk threads from second quality cocoons.

4. Cordonnet, or sewing silk (embroidery silk), consists of more or less twisted organzine threads. Single silk (Pelseide) is twisted from 8 to 10 inferior cocoon threads, and is employed as the foundation for gold and silver tinsel thread.

The above-mentioned silks are not—as is frequently though erroneously assumed—prepared by spinning. Nevertheless, irregular cocoons, such as are difficult to wind, "strussi," or those from which the moth has escaped, and double, bitten, or perforated cocoons—in short, all waste silk—form the raw material of the spun silks met with in commerce, as "flock" or "florette" silk, "chappe" silk, "spun" silk. The waste from these latter again constitutes "bourette".

[1] A description of the apparatus for conditioning silk will be found in Herzfeld's *Technical Testing of Yarns*, etc., published by Scott, Greenwood & Co., London.

Even here the spinning capacity of silk waste is not exhausted, and a number of low-grade threads (also termed "bourette") are prepared therefrom, and utilised for ladies' dress materials, fancy goods, embroideries, cleaning cloths, etc.

All these latter spun yarns are outside the category of true silk, and are numbered in the same manner as the other spun silks.

In addition to true silk, there are also the varieties known as wild silk, mussel silk (from *Penna nobilis*, etc.); and of late years artificial silk has been introduced.

The most valuable of the wild silks is that produced by the Tussah or oak moth, and known as Tussah silk.

The silks produced by all other larvæ, etc. (as also artificial silk), are less highly regarded in commerce, on account of their lower tensile strength, smaller quantity, or inferior appearance; and, as a rule, are used only for mixing.

From the particulars of the different systems of numbering already given, it is evidently not a matter of indifference whether a silk No. is marked by one method or another indiscriminately; because each system is based either on a different weight or length to the others.

If now it is desired to ascertain the equivalent of No. 1 of one system in another system, the same procedure must be followed as in the spun yarns, *i.e.*, multiply the number of weight units (grams) per denier of the one system with the number of length units (metres) per denier of the other system, and divide the resulting products.

It should be noted that the word "denier" is erroneously employed in commerce in place of "gran," and this should also be so understood in the conversion calculation referred to.

Below is appended a table of the mutual ratio of the chief titres. From this a given No. can be converted into the

corresponding No. of another system, by multiplying the former on the ratio factor given in the column for the latter.

Mutual Relation of the Chief Silk "Titres".

International, 500 m. per denier of $\frac{1}{20}$ gram.	New Lyons, 500 m. per gran of 0·0531 gram.	Old Lyons, $475\frac{3}{8}$ m. per gran of 0·0531 gram.	Turin, 450 m. per denier of $\frac{1}{20}$ gram.	Milan, $475\frac{3}{8}$ m. per gran of 0·051 gram.	Piedmont, $475\frac{2}{8}$ m. per gran of 0·0533 gram.
1	0·9416196	0·8952448	0·9000000	0·9321078	0·8913838
1·0620000	1	0·9507500	0·9558000	0·9898985	0·9471825
1·1170128	1·0518013	1	1·0053116	1·0411765	0·9962477
1·1111111	1·0462440	0·9947165	1	1·0356754	0·9909839
1·0728372	1·0102046	0·9604520	0·9655535	1	0·9568480
1·1218512	1·0557627	1·0037665	1·0090981	1·0450980	1

The length of 1 kilo (2·2 lb.) of silk should therefore be :—

International	titre	10,000,000	metres	=	10,936,330	yards.
New Lyons	,,	9,416,146	,,	=	10,297,780	,,
Old ,,	,,	8,952,448	,,	=	9,790,666	,,
Turin	,,	9,000,000	,,	=	9,842,697	,,
Milan	,,	9,321,078	,,	=	10,193,810	,,
Piedmont	,,	8,913,838	,,	=	9,748,441	,,

The actual length received (percentage of loss) must be left to personal experience.

APPENDIX.

A FEW USEFUL HINTS.

Calculating Warps.

In the case of warps all of one colour, the total number of threads in the width is multiplied by the warp length, and the product, divided by the calculated length of a hank, gives the number of hanks required,

e.g., No. of threads $\dfrac{2460 \times 71{\cdot}59 \text{ yards}}{1027\frac{1}{2} \text{ yards}} = 171$ hanks.

Where warps of more than one colour are used, it must first be clearly ascertained how many threads of each colour (also quality or strength) are contained in the whole width.

Example: Total threads, 3640; length of warp, $54\frac{1}{2}$ yards; No. of threads per repeat: 46 brown, 2 blue, 14 black (total 62).

$3640 \div 62$ threads per repeat $= 58$ repeats on 44 threads.

46 brown	×	58	=	2668	+ 44	=	2712	brown threads.
2 blue	×	58	=	116	+ 0	=	116	blue ,,
14 black	×	58	=	812	+ 0	=	812	black ,,

Total, 3640 threads.

Brown: $\dfrac{2712 \times 54\frac{1}{2} \text{ yards}}{787 \text{ yards}} = 188$ hanks.

Blue: $\dfrac{116 \times 54\frac{1}{2}}{787} = 8$,,

Black: $\dfrac{812 \times 54\frac{1}{2}}{787} = 56$,,

Weft Calculations.

Multiply the number of picks per inch by the length of the cloth, and the product by the width of the reed in inches, and divide the result by the length of a hank in yards: *e.g.*, picks per inch, 70; length of cloth, 18·2 yards; width of reed, 40 inches; length of hank, 480 yards.

$$\frac{70 \times 182 \times 40}{480} = 106 \text{ hanks required.}$$

In the case of coloured (checked) fabrics proceed as follows:—

Multiply number of repeats per yard by the length of the piece, the product by the reed width, and the result by the number of threads of the one colour per repeat, dividing the total by the length of a hank.

Example: Number of repeats per yard, 24 of 96 threads + 16 threads over.

Length of piece, 66·7 yards; width of reed, 1·1 yard; pattern: 40 threads Bordeaux, 18 cream, 38 olive; total, 96.

Threads $\frac{16 \times 66{\cdot}7}{96} = 11$ repeats.

Repeats, $24 \times 66{\cdot}7 = 1600{\cdot}8 + 11 = 1611{\cdot}8 \times 1{\cdot}1 = 1773$ yards, contain one pick of the total repeats.

Bordeaux: $\frac{1773 \times 40}{940} = 76$ hanks.

Cream: $\frac{1773 \times 18}{940} = 34$,,

Olive: $\frac{1773 \times 38}{940} = 72$,,

Calculations of Cost Prices in Hanks.

Example: What is the cost of 69 hanks of No. 36 yarn at 1s. per lb.?

The price of one hank at this rate is $\frac{12}{36}$ pence; hence this price multiplied by the total number of hanks gives the answer, *viz.*:—

$$\tfrac{12}{36} \times 69 = 1\text{s. } 11\text{d.}$$

In the case of doubled yarn (twist) one hank would cost $\frac{12}{18}$ pence, because only 18 hanks go to the lb.

For 3-ply yarn the following method is pursued :—

Example : What will 69 hanks of 20/3 cost at 1s. per lb. ?

$$\frac{12\text{d.} \times 3 \text{ (ply)}}{20} \times 67 = 124\cdot2\text{d.} = 10\text{s. } 4\tfrac{1}{4}\text{d.}$$

The weight of a given number of hanks in lb. is found by dividing them by the yarn No. in the case of single yarns; thus 67 hanks of No. 36 yarn weigh $67 \div 36 = 1\cdot861$ lb.

The same number of hanks of this No., if of doubled yarn, would weigh $67 \times \frac{36}{2} = 3\cdot722$ lb.

In 3-ply yarn the number of hanks is multiplied by 3 and divided by the yarn No., *e.g.* :—

67 hanks of 20/3 yarn weigh—

$$\frac{67 \times 3}{20} = 10\cdot05 \text{ lb.}$$

This plan holds good whatever unit of weight (lb., kilo, etc.) be adopted.

Calculation of the Cost of Different Lengths of Warp or Cloth from a given Length and Price.

This is a matter of simple proportion. For example: What will 40 yards of cloth or warp cost when the price of 45 yards is 36s.?

$$\frac{40}{45} \times 36 = 32\text{s.}$$

Calculating Reeds for Unequally-Distributed Warps.

Example I.

A total number of 4800 warp threads is to be distributed as under :—

1 dent = 3 threads.
1 ,, = 4 ,,
—
7 threads per 2 dents.

$4800 \div 7 = 686 \times 2 = 1372$ dents are necessary.

Example II.

4540 warp threads are to be arranged as follows :—

1	dent	=	4	threads.
1	,,	=	3	,,
1	,,	=	3	,,
			10	threads per 3 dents.

Here 4540 ÷ 10 = 454 × 3 = 1362 dents are required.

Determining the Number of Dents per Unit of Length.

Divide the number of dents by the width of the reed, and the quotient will be the answer required, *e.g.* :—

926 dents ; reed 64 inches :—

926 ÷ 64 = 14·47 dents per inch.

926 dents ; reed 160 centimetres wide :—

926 ÷ 160 = 5·79 dents per centimetre, or 57·9 per decimetre.

Sizing the Warp.

Warps are still often sized by hand, *i.e.*, with the hand-sizing machine. The usual dressing for 10 lb.—or from 8 to 12 lb. of warp—is 1 lb. of good size, previously steeped in cold water until thoroughly swollen, then mixed with 2½ quarts of water at about 50° C. (122° F.), and passed through a fine wire gauze sieve, or better still, through a filter bag.

The warp must be made just so damp that when tightly twisted by hand, only a moderate amount of liquid appears on the surface.

An addition of a handful of soda to the size, for every 65 to 70 lb. of warp, will render the latter supple.

If the size is too hot or too cold, or too much of the liquid is left in the warp, the consequences will be unfavourable. It is sufficient to mention this here without going more closely into particulars.

Pickers.

To obtain good durable pickers, they must be prepared in the following manner:—

Since the hide for this purpose is so manipulated as to attain a high degree of suppleness, and, consequently, as a rule, contains moisture, the straps ought to be hung up for a few weeks before use, in a dry but not hot place, preferably in a good draught. They are then steeped for three or four weeks in animal oil (bone oil or fish oil, but *not* mineral oil), and are afterwards hung up to drain and dry in an airy—but not hot—place, for at least six months—or even two years. As the drying progresses month by month, so the strips increase in durability, and finally become like bone.

Prolonged drying also precludes the risk of the weft becoming spotted with grease stains from the picker.

Pickers with two rivets at the head end are frequently used. Rivets should only be inserted after the picker is thoroughly finished, *i.e.*, prepared and dried.

The best quality of pickers alone should be purchased, because one good picker will outlast two or more bad ones. It is therefore inadvisable to choose the latter in order to effect a small economy.

It is advisable not to be niggardly in purchasing new pickers, but to lay in a good stock, in order to give them ample time to dry. This course will be attended with compensating advantages.

Harness.

In setting up or building harness, it is, above everything, necessary to ascertain how many threads and lengths of same are required (and, consequently, how many altogether), and of what strength. Also, whether they are to be suspended on the needle cords by means of swivels, loops, or

rings; and, further, the dimensions and shape of the mails, as well as their movement, must be borne in mind. Finally, the most important point of all, the weights—how many to the lb.—must be determined.

The cords vary in thickness from $\frac{1}{75}$ to $\frac{1}{25}$ of an inch, *viz.*:—

Harness for fine warps, silk, etc.,	$\frac{1}{75}$	to	$\frac{1}{60}$	of an inch.
,, medium warps	$\frac{1}{50}$	,,	$\frac{1}{30}$	,,
,, heavy ,,	$\frac{1}{28}$	,,	$\frac{1}{25}$	,,

The degree of displacement of the mails varies according to the goods and the height of the shed. Thus it may be:—

In clothing looms,	top 5,	underneath	9	inches.
In buckskin	,, $8\frac{1}{2}$,	,,	$8\frac{1}{2}$	,,
In damask	,, 5,	,,	9	,,

The determination of the form and size of the mails may be left to the maker.

An important point is the selection of weights (lingoes). If too heavy, the machine works harder, the harness threads soon become worn out through rubbing, and the mails and weights will drop before long. In the converse case, *i.e.*, when the weights are too light, danger is incurred of the warps in the bottom shed lifting, so that the weft misses them and gives rise to faults; or, in power looms, the shuttle may be thrown out.

The method of selection is as follows: A ratio of 1 : 3 is taken, *i.e.*, for a No. 1 metric warp, 3 irons, each weighing 1 kilo (2·2 lb.), are required; a No. 10 yarn taking 30 irons, and so on, so that No. 80 (metric) yarn will require 240 irons (total weight 521 lb.)

N.B.—The conversion of other systems of yarn numbering into the metric system has already been detailed.

When several kinds of yarn are put in the same mail the yarn Nos. must be considered in weighting. Thus 3 threads of No. 30 (metric) are equivalent to 1 of No. 10; and No. 40/2 is equal to No. 20 single.

The iron weights are of various lengths, and this question chiefly concerns the maker. They should not however be too short, or they may catch one against another; 10 inches is a convenient average length.

The height of the board is adjusted so that there is room for a vertical stroke of about six inches between the loop connecting the mail to the threads and the lower face of the bar. Setting too high should be avoided, because, in the first place, a considerable distance between the board and the machine helps to lengthen the life of the threads, and secondly, harness with a high board has a greater tendency to sway.

The stroke must be allowed for in every arrangement, to prevent the loops from coming in contact with the holes of the board when the machine is lifting.

The threads are all cut, either to the same length, or, in the case of wide mails, more economically into three or four different lengths.

A measuring cord is employed, which is drawn towards the left hand, from the end of the cord from the first hook, to the last hole in the board, a margin of two to four inches more being allowed to make sure of having length enough.

Where three or four different lengths are cut, the measure is always taken to the farthest hole for each set.

The threads can be attached to the machine either out of the loom, *i.e.*, in the lowered position, or in the loom itself. Swivels are to be preferred for hanging, because the entire harness can then be disconnected and taken to another loom, or else, in part, thrown out of work as required.

After attaching the threads to the machine, they can be dressed. For this purpose the following procedure is recommended:—

Sixty parts of a non-fatty so-called "double" (*i.e.*, twice

boiled) varnish are boiled with forty parts of wax, the mass being then left to set in a moderately cool place. A bundle of the cords is then dressed over with this preparation, by the hand, for its whole length, the whole being well rubbed down by hand to disperse any lumpiness. All the rest of the cords are treated in the same fashion.

It is well to hang the harness up to dry, when this can be done; and the dressing can be applied by brushing with a hard brush instead of rubbing in with the hands. In such event, however, the dressing must be more fluid, *i.e.*, contain a larger percentage of varnish.

In many instances, only the parts exposed to the most friction are varnished; but it is better to have the whole dressed, in order to prevent unequal expansion or contraction due to changes of temperature or weather. This also prevents the twisting of the mails, a point in respect of which wire mails are superior to cords in protecting the warp from breakage.

It is better to buy the varnish ready-made than to go to the trouble of compounding it oneself.

The threads being attached in position, the mails are weighted and then fastened to the cords. To this end two wooden laths, provided with fine slits, are fixed parallel underneath the comber board; a knitting needle, on which the eyes of the mails forming a diagonal row of the board have been threaded, is stuck in the slits, and tying up begins.

Commencing at one side, the same procedure is followed, from one cross row to another, until the entire harness is finished.

In top-shed machines, the mails must form a half-shed underneath, whilst in top and bottom shaft machines they must maintain a position parallel to the breast and taking-off beams.

In the appended Fig. 1 is shown the loop for attaching the

mails, and also for fastening the hook cords on to the neck cords.

For silk-weaving machines, it is of great advantage to use only half mails. Nevertheless, the harness threads must be cut much longer, because they have to be passed through the comber board, then through the mails and drawn back up again through the same holes in the board, above which the ends are made fast at different heights. Thus the harness threads form the upper half of the mail. Any sticking of the cords is precluded, the loops above the board being at various and irregular levels.

Although the fitting up of such a harness takes more time, the results are entirely compensated by the increased advantages derived. One of these loops is shown in Fig. 2.

Fig. 1.

Fig. 2.

Reliable Mandarin Weavings.

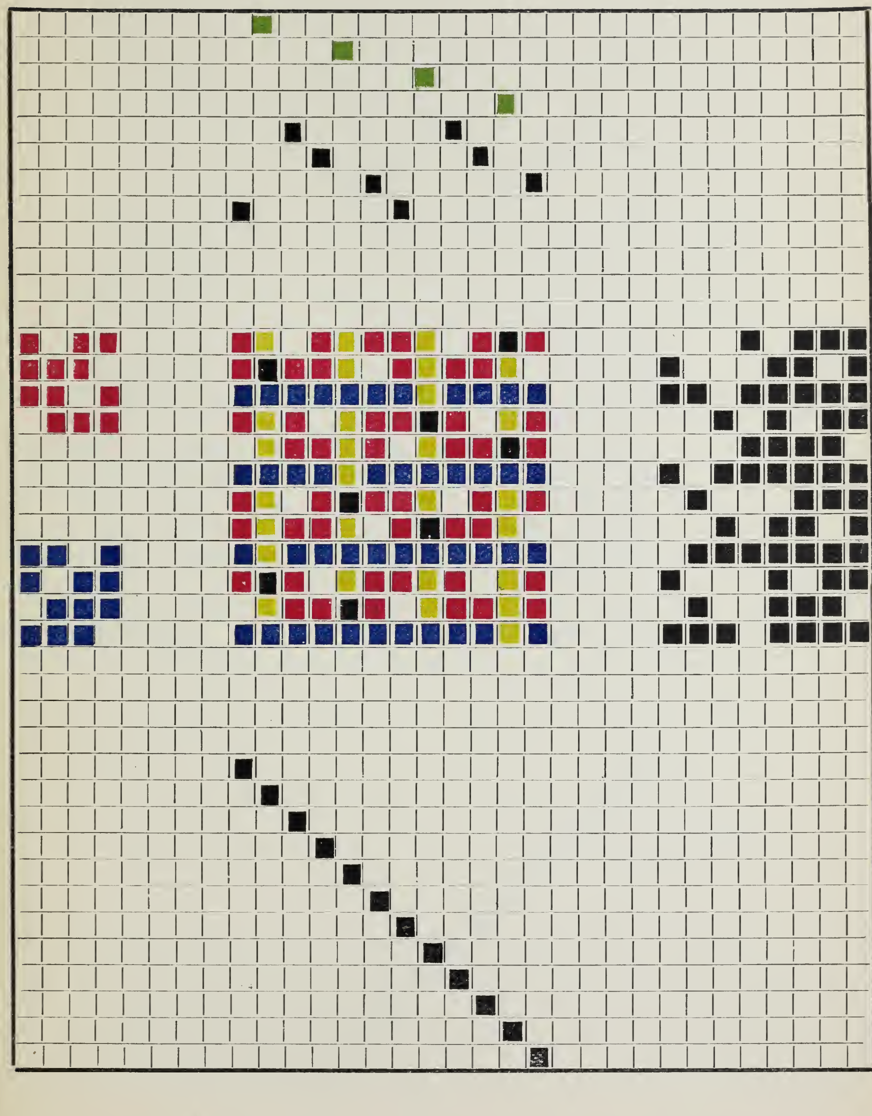
In making goods of this class, it is an indispensable condition that the pattern must be as clearly defined as possible on the face of the cloth, without any haziness; and it is therefore advisable to make use exclusively of the three following old and approved tie-ups: *a*, being best for light stuffs; *b*, for medium, and *c*, for heavy goods.

The two first require with even draft twelve shafts, with uneven draft eight shafts, whilst the last takes twelve shafts with even draft, and each has twelve cards or treadles.

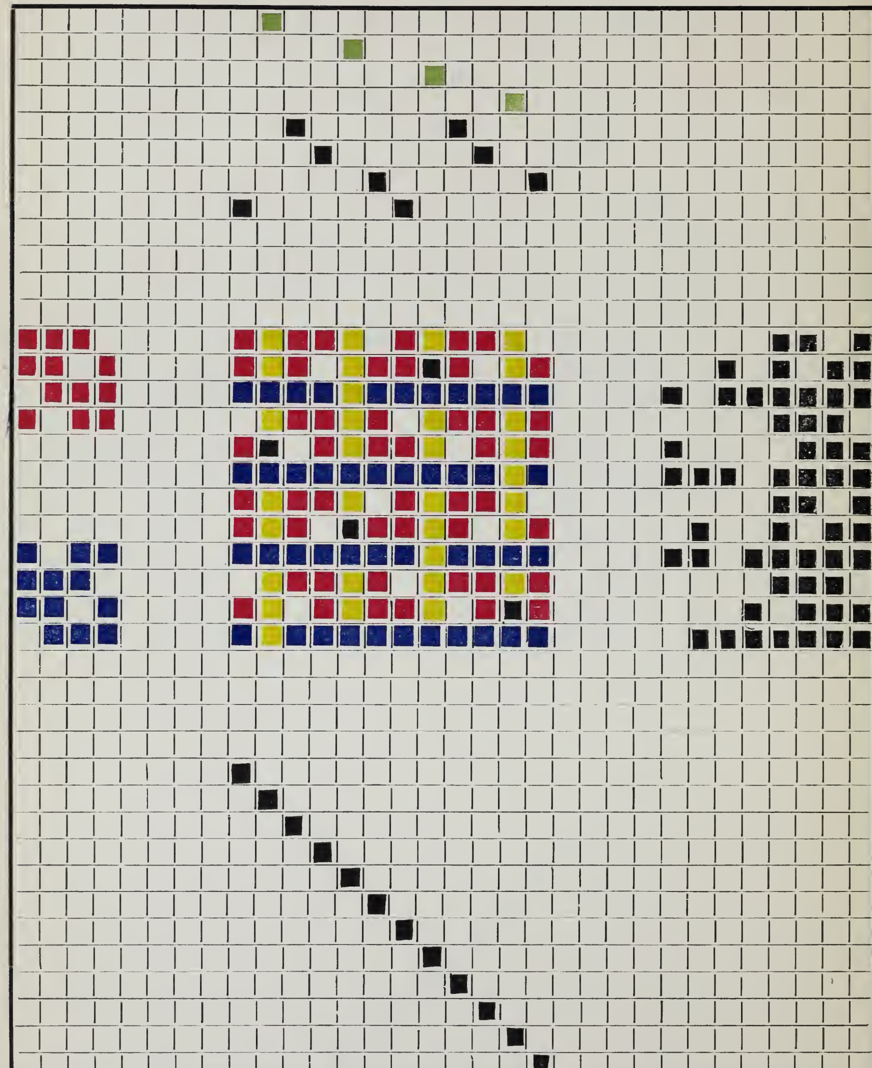
It may be stated that *b* and *c* show up the cleanest in the piece.

In the diagrams, red, blue and black, indicate warp; yellow and white denoting wefts. As a rule, the cloth is woven with the reverse side up, consequently white and yellow are to be punched.

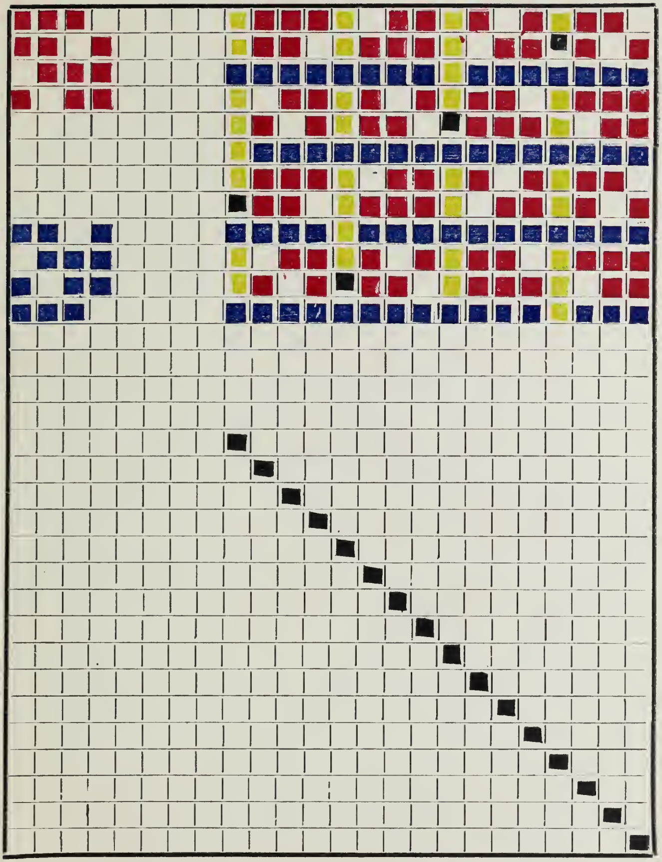
(*a*)



(b)



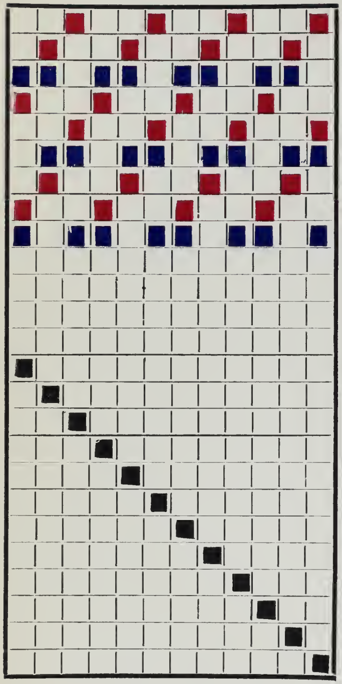
(c)



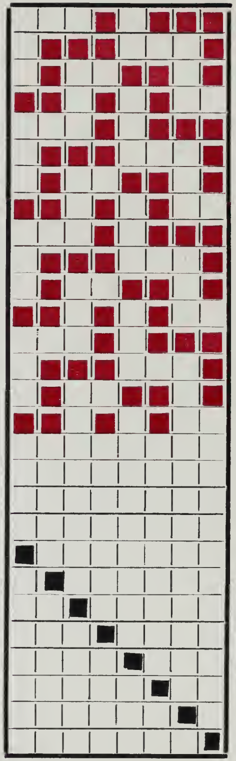
TRICOT WEAVINGS.

Another article in extensive use for gentlemen's suitings is the so-called diagonal tricot; also long tricot—both of which are shown in the diagrams below. In order to secure a better shed-formation, the diagonal tricots are woven with twelve shafts, although only three shafts are really necessary.

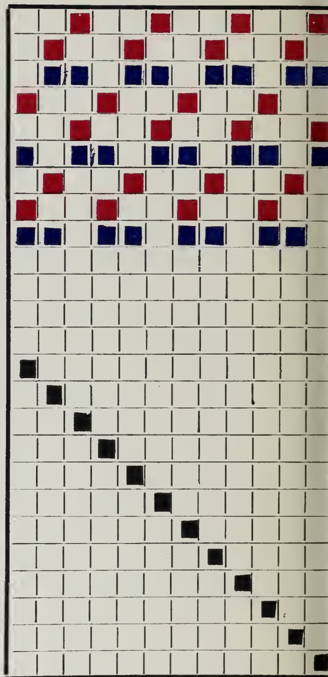
Diagonal Tricot.
12 shafts.
18 picks.



Long Tricot.
8 shafts.
4 picks.



Diagonal Tricot.
12 shafts.
18 picks.



Influence of Yarn Twist on the Weaving.

In all woollen yarns, combed or carded, where the tie-up influences the appearance of the fabric, regard must be paid to the twist of the yarn. Thus, with a yarn with a left-handed twist, the pattern must ascend from left to right.

Where, however, the weaving is intended to be marked, *e.g.*, in heavily-milled goods, the pattern must ascend in an opposite direction to the twist of the yarn. This principle is of minor importance in cottons and other fabrics.

FINIS.

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